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GEOLOGICAL SURVEY OF PENNSYLVANIA.

FINAL REPORT ORDERED BY LEGISLATURE, 1891.

A

SUMMARY DESCRIPTION

OF THE

GEOLOGY OF PENNSYLVANIA,

IN THREE VOLUMES,

WITH

A NEW GEOLOGICAL MAP OF THE STATE,
A MAP AND LIST OF BITUMINOUS MINES,
And many Page Plate Illustrations.

J. P. LESLEY, State Geologist.

VOL. III. PART II.

DESCRIBING THE

BITUMINOUS COAL FIELDS,

E. V. d'INVILLIERS,

AND THE

NEW RED OF BUCKS AND MONTGOMERY COUNTIES,

BENJAMIN SMITH LYMAN.

HARRISBURG:
PUBLISHED BY THE BOARD OF COMMISSIONERS
FOR THE GEOLOGICAL SURVEY.
1895.

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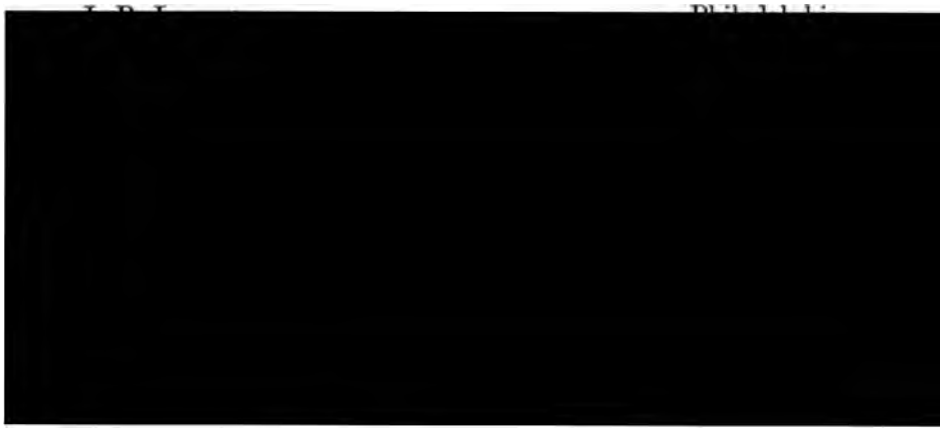
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STATE GEOLOGIST.



LETTER OF TRANSMITTAL.

To His Excellency Governor Daniel H. Hastings, *ex-Officio Chairman of the Board of Commissioners of the Geological Survey of Pennsylvania:—*

Sir:—For the benefit of those who may not possess copies of the previous volumes of the Final Report it seems fitting to introduce a word of explanation with regard to its arrangement.

The first two volumes pages 1 to 1628 were written and illustrated by the State Geologist, Prof. J. P. Lesley, and contain descriptions of the several geological formations in the State from the Archaean base up to and including Formation IX, the Catskill sub-division of the Palæozoic System.

The third volume is devoted to the Carboniferous System, and pages 1629 to 1832 of Part I were contributed by the State Geologist, descriptive of the Pocono formation No. X and in part the Mauch Chunk formation No. XI, in the Anthracite District.

Inasmuch as Prof. Lesley's serious indisposition prevented his completing his admirable work, the Board of Commissioners requested two of his former assistants to carry forward the Summary Report as far as possible on the lines so carefully arranged by the State Geologist. Therefore the balance of the Mauch Chunk formation No. XI in the area west of the Anthracite District and the whole of the Pottsville Conglomerate formation No. XII, pages 1833 to 1915, were prepared by Mr. E. V. d'Invilliers, and are followed by a description of the Anthracite Coal Fields by Mr. A. D. W. Smith pages 1915 to 2152, completing Vol. III part I.

The present report, Part II of Volume III, contains the

completion of the Carboniferous System, embracing the bituminous coal-fields of the State, pages 2153 to 2588 by Mr. E. V. d'Invilliers, and a brief report on the Mesozoic or New Red formation by Mr. Benjamin Smith Lyman.

It must be clearly understood by the citizens of the State and the general public that these three volumes merely aim to present in a condensed form a summary of the labors and reports of many assistant geologists issued during the progress of the *Second Survey*, 1874 to 1891, and are in no sense a *Third Survey* of the State. And as an explanation of and apology for any deficiencies and possible errors in Volume III it is but just to add that the Board was entirely without funds pending its preparation to enable examinations to be made of newly developed fields or to investigate doubtful conclusions made during the early years of the Survey, and that the services of the gentlemen whose reports are embodied in this volume were entirely gratuitous and voluntary.

WILLIAM A. INGHAM,
Secretary.

320 Walnut street, Phila., March 1, 1895.



VOL. III, PART 2.

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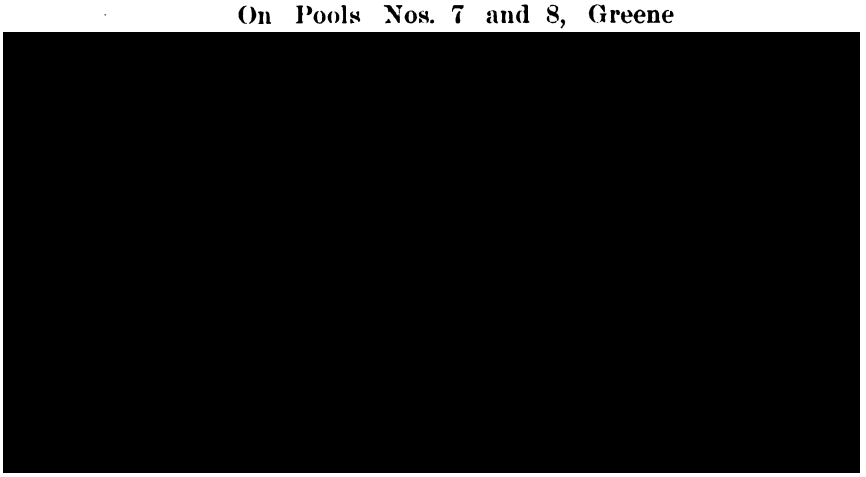
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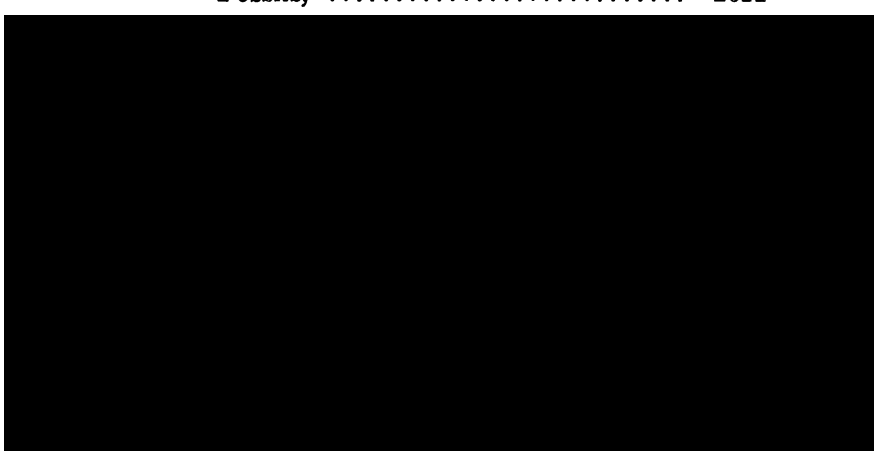


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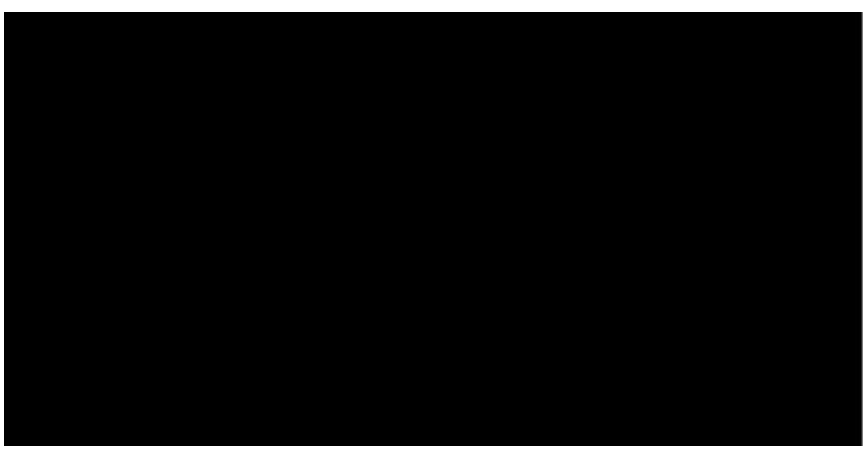


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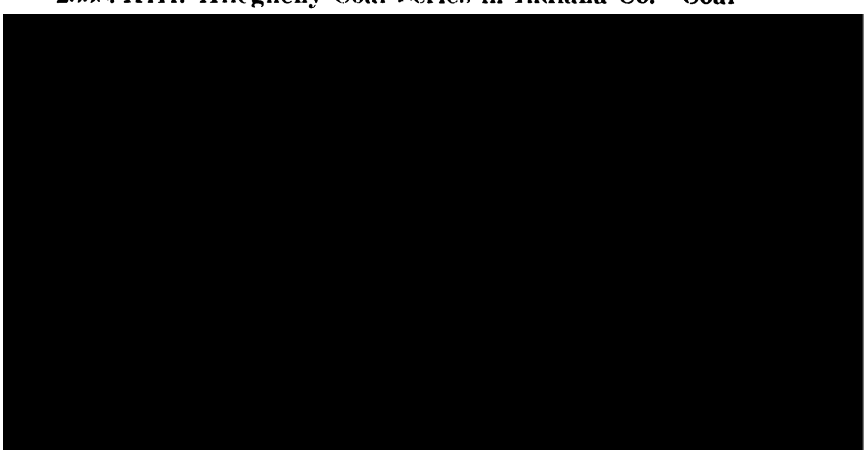
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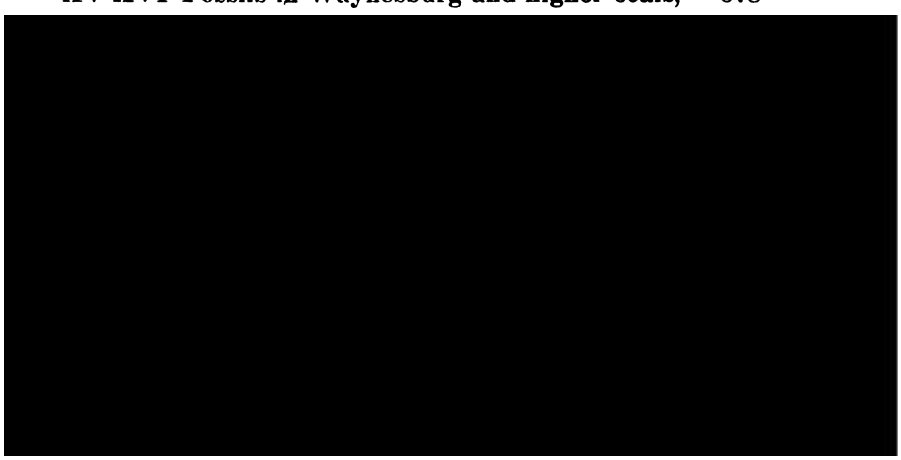
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The Carboniferous System.

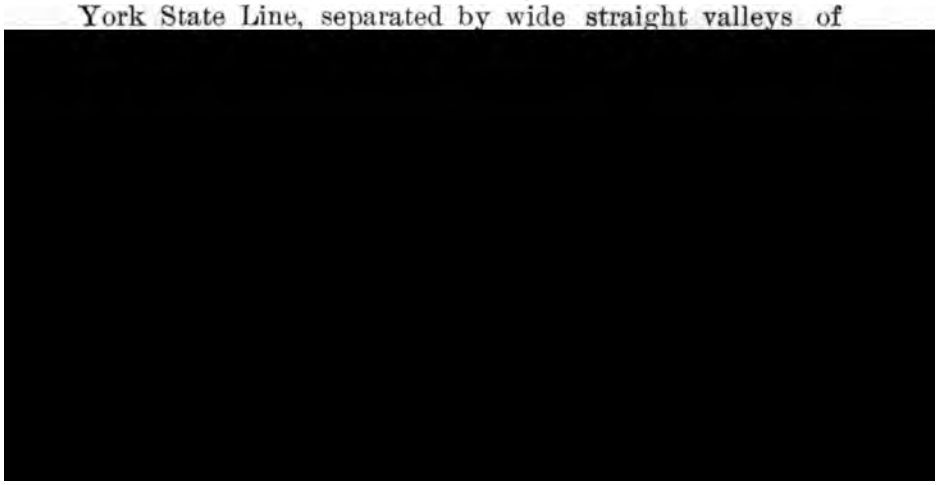
The Coal Areas* of the United States are few and well defined, but some of them of great size; the eastern bituminous, or *Appalachian Area*, contains about 65,000 square miles.

Beginning at the northeast, we have the coal beds of Maine, continuations of those of New Brunswick, over a small area of confused and distorted rocks, very little known, and covered with a thick deposit of northern drift. Nothing, as yet, promises for this area a future of any importance.

The same is true of the narrow pointed basins of crushed anthracite stretching across Rhode Island into southeastern Massachusetts. The almost vertical pitch and dislocated and crushed condition of the one or two workable beds here explored, with the slaty character of the coal itself, have deceived the expectations originally formed and repeatedly renewed, that the manufacturers of New England would find, in these deposits, a second Schuylkill or Carbon Co., Penna. Here and there, in middle Massachusetts, near Worcester, small lenses of a coal formation have been discovered; but not worth exploration. All these appear to be outliers of the Pennsylvania Anthracite basins, the coal beds being enclosed in rocks referable to the same era. They resemble, in their dynamic structure, the isolated sharp and narrow basins in Pennsylvania, caught in between steep enclosing walls of turned up older rocks, and thus preserved from that wide waste which has removed the coal from the whole summit plateau of the Catskill mountains, and perhaps from the whole breadth of intervening country between the Hudson and St. Johns.

*They belong to different geological ages, and possess distinct characters. In Rhode Island, in Eastern Pennsylvania, in the Peak range of southern Virginia, and in Arkansas, the coal is anthracite or semi-anthracite. These are disturbed geological regions, and border upon primary or metamorphic rocks.

The *Great Appalachian Bituminous Coal area** extends from northern Pennsylvania to middle Alabama, 800 miles, in an unbroken sheet of Coal Measures, with a clean, gently waving, but on the whole, nearly straight southeastern outcrop edge, through middle Virginia and eastern Tennessee; along the crest of the Allegheny mountain, until it reaches the Virginia-Tennessee line, whence southward it is known as the Cumberland mountain. Measured cross-wise this vast area is of very various widths, rolling its immense billows, like sea waves on the shore, into middle Ohio, eastern Kentucky and middle Tennessee. Its western outcrop is as irregular as the eastern is regular; being scolloped, frayed, or broken up into shreds and outlying patches, occupying the tops of narrow ridges and isolated knobs, overlooking like frontier forts, the great open plain country of the west. This irregular line runs along the Pennsylvania-New York State Line, crosses Ohio from Meadville and Massillon, past Loar and Athens to Hanging Rock and Ironton; crosses Kentucky west of Greensburg and Irvine; traverses Tennessee as the western brow of the great Cumberland plateau, and joins the eastern outcrop at the ends of one or two long finger-shaped basins on the summits of mountains in middle Alabama. The northeastern end of the great area is broken into five similar mountain summit basins, running out toward the New York State Line, separated by wide straight valleys of



more and more coal measures, and at last merging into one great area covering all the land.

In Pennsylvania the *Carboniferous formation* has been subdivided into four main systems above the *Conglomerate Series No. XII*, which will be described separately, beginning with the oldest first.

CHAPTER CXXIV.

No XIII. Lower Productive or Allegheny River Coal Series.

The *Productive Coal Measures No. XIII** might, for all pratical purposes, be reviewed as embodying all the balance of the *Carboniferous Series* from the top of the *Homewood Sandstone* (upper member of No. XII) to the highest coal measure bed in the south-western corner of the state, although this vast group of rocks, with a thickness of from 2000′ to 2500′, has been sub-divided as follows by the Second Survey:—

4. *Upper Barren Measures* { *a. Greene Co. group.* / *b. Washington Co. group.* } No. XVI.
3. *Upper Productive Measures or Monongahala River Series*, No. XV.
2. *Barren Measures or Pittsburgh Series*, No. XIV.
1. *Lower Productive Measures or Allegheny River Series*, No. XIII.
Pottsville Conglomerate; Homewood sandstone, No. XII.

The *Lower Productive group*, as now limited, is confined between two great and widespread sandstone forma-

*The *Lower Productive* or *Allegheny River Coal Series*, received its name from the fact that, prior to the discovery of coal beds within the Conglomerate Series, this group of rocks, 200′ to 300′ thick, comprised the lower of two such "productive" groups in western Pennsylvania, and was first well studied and developed along the Allegheny river. Much was known of its individual coal beds and rock intervals as a result of the First Survey 50 years ago and the development of individual enterprise; but the Second Survey, during the past 20 years, has had ample opportunity of amplifying our knowledge of this group. The *Lower Productive Group* has no more coal beds now than formerly and few real discoveries were possible; but there has been an infinite amount of painstaking stratigraphical work done between 1874–1890, which has served to establish now for all time the characteristics of its triple coal series, the *Freeport*, *Kittanning* and *Clarion groups*, though it required years of careful cross-sectioning and comparison to bring the present comparative order out of the confused and chaotic nomenclature in use in each local mining district prior to 1874.

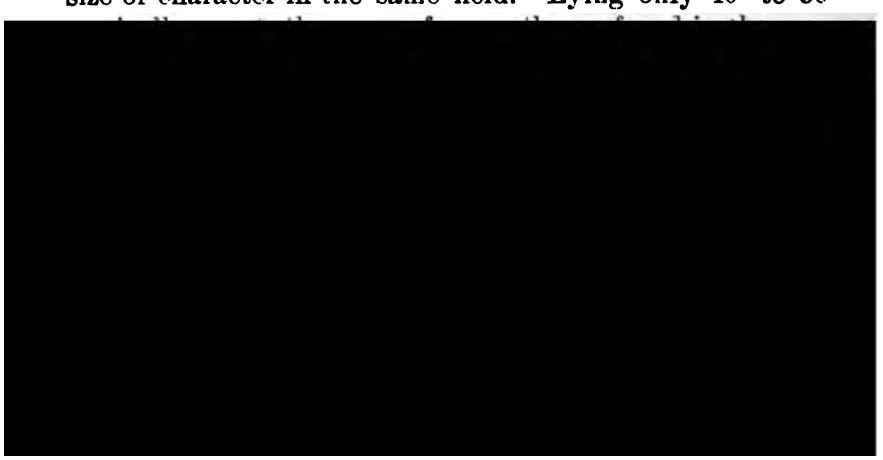
tions: The *Pottsville Conglomerate* below and the *Mahoning Sandstone* above. After the study of these rocks was carried out in many counties, the following scheme was finally adopted to represent the general sucesssion of the group:—

Mahoning Sandstone; base of Barren Measures: No. XIV.

*Lower Productive or Allegheny River Series No. XIII**	Freeport upper coal bed E.
	Freeport upper limestone
	Freeport lower coal bed D.
	Freeport lower limestone.
	Freeport sandstone.
	Kittanning upper coal bed C'
	Johnstown Cement (limestone)
	Kittanning middle coal bed C.
	Kittanning lower coal bed B.
	Kittaning sandstone
	Buhrstone iron ore.
	Ferriferous limestone.
	Clarion coal bed A'.
	Brookville coal bed A.

Homewood sandstone; top of Conglomerate No. XII.

Broadly speaking, commercial importance and pre-eminence attaches in Pennsylvania mainly to the two *Freeport coals*, *E and D* (and to a much more limited extent to the *upper* and *middle Kittanning beds* in western Pennsylvania) and to the *Kittanning lower coal B.* Of the two former it may be stated that the past 20 years of development has proven that both are rarely found of commercial size or character in the same field. Lying only 40′ to 50′



ior to the Freeport coals chemically, except perhaps along portions of the Allegheny plateau in Centre, Clearfield, Cambria and Somerset Cos. where it is a bed of great purity and value. Here too the *Kittanning upper coal C'* frequently becomes of good quality, with a thickness of 2' 8" to 4', especially in parts of Somerset, Indiana, and Clearfield, and in parts of the Beaver and Shenango River districts. The *Kittanning middle coal C* is generally slaty and worthless, except perhaps in portions of the western counties, where too the *Clarion* and *Brookville* beds become workable and acceptable to the trade.

But all of the beds of the series thicken and thin in districts; change their character and partings; widen their intervals between one another and rarely furnish over 4' of merchantable coal, except in comparatively small areas. It was owing to these irregularities of bed section, character of partings and interval, which gave rise to false identification and great loss of money in mining, men insisting upon identifying coal beds in widely distant parts of the coal field by characteristic (?) partings, floor, roof or bony matter. But it is now pretty well understood (as a result of the progressive studies of many assistants on the Second Survey), that the only safe guides to the identification of coal beds are the rock series accompanying them i. e. the *Mahoning sandstone* and *Pottsville Conglomerate* at the top and bottom, and particularly the *limestone beds* within the Lower Productive Coal Measures themselves.

Hence a very large part of the field work of the past 20 years has been devoted to tracing these strata from county to county through the State, accompanied by numerous vertical sections, with the gratifying result that at the present time no field geologist at work in the *Bituminous Measures* of Pennsylvania need be long in doubt of his approximate horizon, if he can only pick up one of these, key-rock outcrops; it is only where some or all of them are entirely absent that doubt still exists of the proper nomenclature in individual fields. Hence no better nor more important and satisfactory results have followed the investigations of the past 20 years than the tracing and location

of the several key-rocks affecting the Lower Coal Measure group.*

In *Cambria and Somerset counties* the *Freeport upper limestone* is usualy present in the local sections but frequently absent; the *Freeport middle limestone* is usually absent, but frequently present; the *Freeport lower limestone* is almost universally present, but is absent in Clearfield and Centre Cos.† and in Cambria Co. to the north and east of Scalp Level in the Wilmore basin.‡ In the Johnstown section it is locally called "*ferriferous limestone*,"§ but is

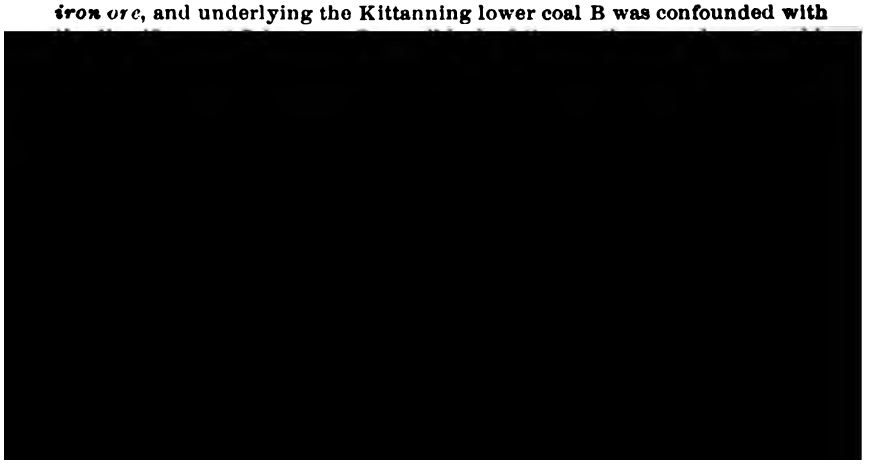
* An instance in point is afforded by Mr. W. G. Platt's section at Rosston Station, Armstrong Co., H 5, page 258.

The Kittanning group is here composed of an upper coal (0′ 8″), interval 20′ 0″; a middle coal (1′ 4″) with a poor limestone; interval 50′0″; and a lower coal (3′0″).

Mr. Platt neglected the upper coal, as local, and called the underlying bed the *Kittanning upper coal* and the poor limestone under it, therefore, the Johnstown cement bed. Mr. White called it the *Kittanning middle coal* and doubted the correct application of the Johnstown cement bed in other places; and therefore the propriety of calling the coal over this cement bed, Kittanning upper coal in the region where it is best studied.

The above example is here cited to illustrate the difficulty, in fact the impossibility, of applying the system to every place in the region. It will be many years before the various outcrops are traced uninterruptedly over the whole country; and until this is done it will be rash to conclude that where a limestone is absent the coal bed over its horizon must be some other bed; or that where a limestone is present it must necessarily be *the* limestone which ought to underlie that particular coal bed. What is true of the Freeport group must be true of the Kittanning group.

Prior to 1876 and for a few years afterwards, the great "*Ferriferous Limestone*" of the Allegheny River district, accompanied by its *Buhrstone iron ore*, and underlying the Kittanning lower coal B was confounded with



not at all the *Ferriferous limestone* of the Allegheny river region, lying at the bottom of the Kittanning group.*

But at the close of the three years' survey of Clearfield, Cambria and Somerset Cos., an attempt was made to harmonize the whole scheme of the *Lower Productive Coal measures*, with what was then known of the series in the Allegheny River country. The three Freeport coals E, D′, D were reduced to two E, D (= D′), and the lowest of the three (D) was made the upper of the two Kittanning coals C′ and C. Consequently the Johnstown cement bed no longer underlaid the *Freeport lower coal* but the *Kittanning upper coal.*†

The time came however when the Kittanning group had to be recognized as triple. In Platt's Rosston section just quoted, the small coal under the great Freeport sandstone was ignored and the next bed was called *Kittanning upper coal* and therefore the limestone under it was considered to be the *Johnstown cement bed.* White calls the small bed *Kittanning upper coal* and the next bed *Kittanning middle coal* and therefore doubts that the limestone under it is the cement bed, because that ought to underlie the Kittanning upper coal.

The fact is, the limestone should be taken as the key, and not the coal bed. For instance, the Cambria Co. coal beds cannot be safely identified with those of Indiana Co.; whereas the *Johnstown cement bed* is finely developed all through the Ligonier valley, north of the Conemaugh.‡ At Lockport it is only 2′; but on Black Lick creek 10′, pure and extensively quarried; on the South Fork it contains 13 % of iron. In the Blairsville basin it varies from 1½′ to 15′.§ In the Saltsburg basin it occupies its proper place near Marion, 3′ thick.‖

In *Armstrong Co.* it is not seen on the Kishkaminitas, and often not on Crooked creek; is usually, but indistinctly,

* H 2 page 98.
† See the new scheme described and explained in H 3 pages 315 to 322.
‡ H 4 page 69.
§ H 4 page 178.
‖ H 4 page 259.

indicated on the Cowanshannock; is not seen on the North Fork of Pine creek; but is well exposed at various places (4′ thick) along the Mahoning and Red Bank creeks; at Kittanning absent, it appears higher up and lower down the river; it is 2′ at the mouth of Crooked creek; is persistent and regular in the Worthington region, a true cement bed and fossiliferous, 3′ to 5′ thick.*

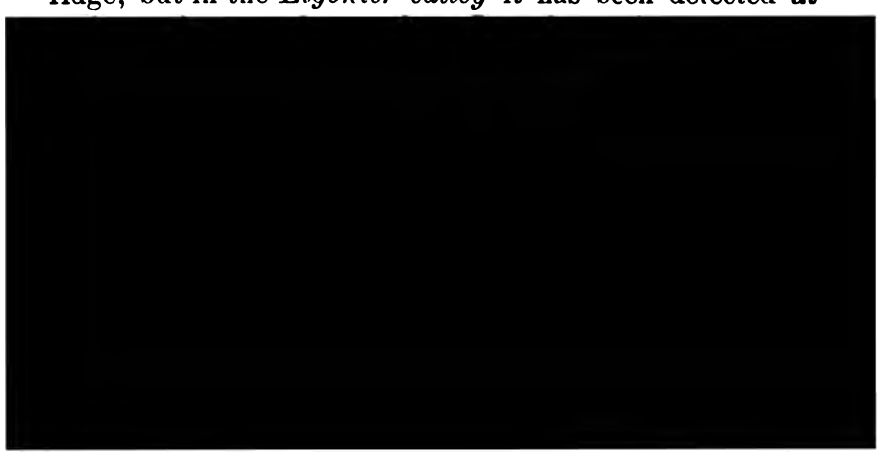
In *Jefferson Co.* the cement bed has been observed at nearly every locality where its horizon is exposed to view, but in most cases as a thin layer, impure and ferruginous, with characteristic minute univalve impressions.†

In *Clarion* Co. the cement bed was seen by Dr. Chance at only one locality, on Middle run, 1000′ north of the Fairmount Co's. mine (on the Freeport lower coal) vaguely called 6′, but probably only 3′ thick, and in reality a self-fluxing iron ore (48% carbonate iron+1.5% sesq. ox. iron).‡

In *Butler* Co. this cement bed is not noticed, except at Argyle, where it is an iron ore (38% carb. iron+ 1.6% sesq. ox. iron).§

On the edge of *Beaver* Co. it is represented by vast numbers of ore balls in the shale beneath the Darlington coal bed.‖ This ore bearing shale ranges through Lawrence Co.,¶ and also through Washington Co. south of the Ohio river.**

South of the Kishkiminitas in *Westmoreland and Fayette* Cos. the cement bed has not been noticed west of Chestnut ridge; but in the *Ligonier valley* it has been detected at



ments of the No. XI limestone; and at one place the ore bearing shale was mined.*

From the above sketch it will appear: 1st., that we have in this *Johnstown cement bed* a calc-iron-clay deposit of great extent; 2nd., that it maintains a fixed relationship in the order of strata; 3rd., that it can be used as an important key-rock for measurement; 4th., that it underlies the first coal bed *under* the great Freeport sandstone; 5th., that it helps to fix the *top* of the Kittanning group.

The *Freeport limestones* have their best development in the western part of the State, and underlying the two upper coals of the section, have fixed the double character of the *Freeport group;* hence in all the recent reports of the Survey the triple form of this series, designating *Upper*, *Middle* and *Lower Freeport* coal seams, has been expunged, through the discovery of false identification of the lower Freeport limestone with the Johnstown cement bed; and *per contra* the *Kittanning group* made triple, as shown in vertical section above. Here too the true *Ferriferous limestone* under bed B has its greatest development and outspread, cropping all along Slippery Rock creek, and up the Allegheny river and branches, east and south into Armstrong and Jefferson Cos., but rarely seen to the east in the Allegheny Mountain district. But just as this later key-rock limestone fades away the next higher *Johnstown Cement bed* (underlying the Kittanning upper coal C') assumes size and importance and is present in most of the sections across Indiana, lower Cambria and Somerset Cos., and in the Ligonier valley of Westmoreland and Fayette.

The *Ferriferous limestone* (underlying Bed B) has been found an almost unerring guide and key-rock to the geology of the lower coal measures in north-western Pennsylvania†. And its limits of utility in this respect are delin-

*K 3, pages 38 and 39, where Prof. Stevenson gives the names of the runs on which it is alternately present and absent.

†The Ferriferous Limestone has been used since the year 1837 as a geological base of measurement and key to identification in western Pennsylvania; a rock perfectly well distinguished, by its size, aspect and fossil contents (see this point stated clearly on page 220 Q) from the other limestones of the *Barren* and *Lower Productive Coal Measures.*

eated on the recently compiled map of the State (Plate II). It is here almost universally a thick rock; shows its outcrop in a multitude of localities, and in most of them supporting the important Buhrstone iron ore. Under the natural supposition that such a deposit, traceable through Beayer, Lawrence, Butler, Clarion, Jefferson and much of Clearfield Co., must needs exist in Armstrong, Indiana†,

---

The geologist can take it as his guide immediately after passing to the west of the Indiana anticlinal, and keep it as his guide throughout Clarion and Jefferson counties; in the coal basins of Elk and McKean, nearly to the New York State Line; and in southern Venango, northern Butler, Lawrence and Beaver counties, to and far beyond the Ohio State Line.

It has a lower blue layer valued by ironmasters, and an upper gray layer much esteemed and largely quarried for furnace, farm and building purposes at a hundred localities.

Finally, it always carries on its upper surface quantities of iron ore, often very large, apparently derived by percolation and precipitation from the ferruginous shale deposits overlying it, and characterized by a more or less localized mixture of buhrstone or chert produced by the same agency. Dr. Newberry, in his Ohio report for 1874, suggests another view of the origin of the ore and chert, as a substitute for the above theory adopted by the geologists of the First Geological Survey of Pennsylvania.

The careful geologist accustomed to take into account all the features of each exposure, and grown familiar once for all with the character and relationships of this remarkable member of the *Lower Productive Coal Series*, the base of the *Kittanning group*, can hardly ever be deceived into mistaking it for the thinner and less fossiliferous Freeport limestone beds, 200′ and 250′ higher in the series, or for the ore bearing Johnstown Cement bed (Butler limestone) under the Darlington coal or bed C′.

Still less can he be so misled as to confound it with the two thin iron bearing and peculiarly fossilferous limestones of the Mercer group, which underly it at a considerable distance in the series, locked up between the two Connoquenessing sandstones.



Cambria and Somerset Cos., the early geologists in these coal fields naturally confounded it with the overlying *Johnstown cement bed*, although it was nowhere accompanied by its typical iron ore, and although it often seemed to appear in a part of the series which did not closely correspond to its geological horizon in the Allegheny River section.

Many other important illustrations and detailed facts might be stated concerning the development of the *Lower Productive Coal Measure field* which followed this harmony in stratigraphical geology; but none were more important or more far-reaching in their effect than the correct interpretation of the limestone strata and the delineation of their separate usefulness as key-rocks for orienting the workable coal beds above and below them.

The second great lesson gleamed from Nature's treasure book, as a result of a comparison of thousands of vertical sections in various parts of the field, is the fact that it rarely occurs that even where the entire coal group is exposed there are more than two beds out of the seven fairly persistent seams which attain workable dimensions or commercial importance.

Thirdly that while the general law previously held to the effect that this series held valuable coal in a broad belt around the margin of the coal field is in the main true, in so far as the coal beds are thicker, better and more numerous there, yet the recent drilling of many oil and gas wells over the central portion of the field, where these beds lie deeply buried, has proved the old idea to have very many exceptions, and has almost caused its total abandonment so far as intimidating the prospector and capitalist from pursuing development.

Finally a long series of chemical researches by Mr. A. S. McCreath, Chemist of the Survey, has evolved the axiom of progressive increase of volatile hydro-carbons in the coal beds from the Allegheny mountain westward to Pittsburgh, though there are still some notable exceptions to this rule.

The investigations carried on in the *Broad Top* and *Anthracite fields* in the eastern part of the State have only

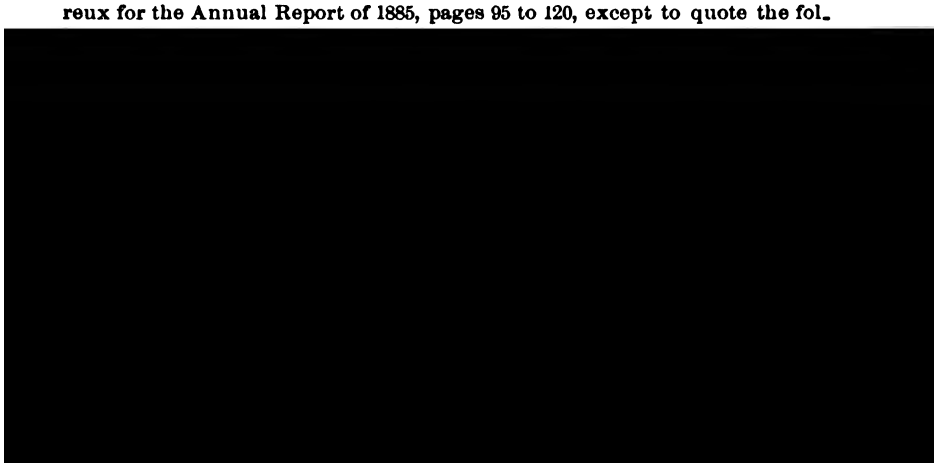
served to confirm the general statement that all of the workable coals in the former basin and many of the seams in the latter area are geologically referable to the horizon of the *Lower Productive group* west of the Allegheny mountain; but no satisfactory scheme of correlation has yet been made out which permits of any more specific statement, except that in chemical composition the coals of each district lend force to the conclusions just stated concerning the proportion of volatile matter to fixed carbon from the east westward.

The *Lower Productive group*, while varying but little from 250′ thick along the Allegheny mountain and 300′ in western Pennsylvania, declines to about 200′ in Ohio around the northwestern border of the coal field, while thickening up rapidly southward to 1000′ on the Great Kanawha and Guyandotte rivers of West Virginia.*

Space does not permit a more elaborate discussion of the various interesting changes these coal measure rocks undergo even within very narrow limits within individual basins in Pennsylvania.†

* I. C. White, Bulletin 65, U. S. Geological Survey, 1891.

† For these facts the reader must consult the following pages and illustrations, summarizing the individual county reports, or better still, refer to the thirty odd volumes on the Bituminous Coals of the State issued by the Survey, of which this present report is necessarily but a brief and imperfect condensation. Nor can I more than incidentally refer to the able and lucid article on the "Vegetable Origin of Coal" prepared by the late Leo Lesquereux for the Annual Report of 1885, pages 95 to 120, except to quote the fol.



CHAPTER CXXV.

No. XIII. Lower Productive Measures.

*The Broad Top Coal Field in Huntingdon and Bedford Cos.**

The Broad Top coal field occupies the deepest geological trough in Pennsylvania and consists of a highly plicated area of coal measures, surrounded by a high mountain rim of the *Pottsville Conglomerate series*, geographically divided by the Huntingdon and Bedford Co. line. Its superficial area is not great, as the lowest coal bed only occupies an area of about 50 square miles; but owing to the severe plication of the rocks and their consequent folding into many roughly parallel subordinate basins, the total coal tonnage of the district has been necessarily very greatly enlarged per acre of ground as compared with the more gently dipping Allegheny Mountain region. In its structure it partakes much more closely of the characteristics of the several anthracite basins; and occupying an intermediate geographical position between the hard coal fields of Schuylkill, Carbon and Luzerne Cos. and the great bituminous field west of the Allegheny mountains, its coal partakes of the character of each district and forms the typical semi-bituminous fuel of the State. The importance of this field in the last few years, as a producer of high class steam coal, has been largely overshadowed by the Maryland and West Virginia districts, where the coal seams are thicker, more accessible and more cheaply mined by reason of their structure, and have therefore displaced, to a large extent, the shipments of coal made from this Broad Top basin at a date prior to the extension of the Huntingdon & Broad Top Railroad system southwest into West Virginia.

* Reports T 2 and T 3, 1885. Lesley, Stevenson and White.

Structurally and *geologically* it is one of the most interesting coal fields in the State, and although its local features are well understood and have been made use of by the operators in the region, to the geologist there are still many interesting unsolved problems which would repay close study.

A somewhat tentative scheme of correlation was presented by Mr. John Fulton and published as a plate of sections in Report T 3* (see plates 396 and 397), wherein an attempt was made to show that the *Upper Freeport coal* or "*Lemon Seam E*" of the Allegheny Mountain series was identical with the *Kelly seam*, or the usual top bed which is exposed and mined at many places in the Broad Top basin; such as Chevington, Sandy Run, Riddlesburg, Langdondale and Kearney.

At some of these points sections have been compiled which seem to indicate the propriety of this correlation, from which fact it necessarily follows that this *Kelly seam* and all the underlying beds in the Broad Top basin down to the top of the Pottsville Conglomerate are the eastern representatives of the Lower Productive Coal Measure series in the western part of the State.†

That some of the Broad Top coals are really the geological representatives of the Lower Productive group of western Pennsylvania there can be little doubt; for the presence of the sub-carboniferous *Mauch Chunk red shale*, 1100′ thick, and the *Conglomerate* series 250′ thick, both [redacted]

PLATE 896

No XIII. Broad-Top District.

Comparative Columnar Sections in Blair, Huntingdon & Bedford

By Jno. Fulton. 1877. Report T 3



certain that their general horizon has been correctly fixed. But for reasons already stated, the attempt at correlating individual beds must be regarded as merely tentative to a more exhaustive instrumental survey before it will be possible to harmonize these sections, one with another, in various parts of the Broad Top field, much less to carry this correlation across the Allegheny plateau to the various well understood beds of the Allegheny Mountain district.

The structure of the region is almost equally subject to this criticism.* The *Broad Top anticlinal* is probably the strongest axis in Bedford Co. east from Tussey mountain, and is by far the best defined. It makes a deep notch in the Pottsville Conglomerate outcrop on the north side of Sherman's valley, and entering Broad Top twp. just west of the Fulton Co. line, it is persistent as the ridge in which head Sandy and Six Mile runs on the west and Trough creek on the east. In this township, however, it suddenly decreases in strength and cannot be traced as a distinct flexure north of Broad Top City. The Coal Measures pass intact over the axis, especially the lower beds; uniting the two great coal basins on either side. Three additional anticlinal axes are shown on the Bedford Co. map to the west of the Broad Top anticlinal, all of them entering the Broad Top coal field on the

*The three counties of Bedford, Huntingdon and Fulton belong to the most complicated belt of the State. The long parallel and alternating strips of color on the maps show this and likewise indicate to the experienced geologist the order and position of the main anticlinals and synclinals. But any attempt to indicate these structural features by straight lines drawn through the coal field would necessarily fail to delineate the varying structure and contortion of the several tightly compressed basins and folds which would alone assist the mining operator in determining the commercial aspects of any one district. This can only be done when the entire region is carefully contoured, levels run between coal outcrops and openings, and cross-sections made from surface dips and underground coal entries, as in the Anthracite maps. Such a piece of work might require a full season's attention; but it would amply repay the time and money expended. At present the broken black lines which are alone shown on the Bedford Co. map are but approximate indications of the actual condition of affairs; for owing to the great imperfection in the township maps used in the field work, it was not possible to represent these anticlinals in a geographically accurate manner. By reason of the same defects the inaccuracies in representing the outlines of the Broad Top field are equally marked, and neither the shape of its borders, nor the spread of the colors representing the coal measures and underlying conglomerate, will bear close criticism.

south along Sherman run and notching the terrace ridges of red shale and conglomerate which surround the coal basin; but none of them can be carried northward as distinct flexures into the coal field itself, although their effect has been made manifest locally at many points. It is no doubt owing to their influence that the northern end of the coal field in Huntingdon Co. shows three strongly marked fingers north of Shoup's run, sub-dividing the general basin into as many narrow troughs before the great upland plateau of Conglomerate is reached along the Todd-Carbon twp. line, where the dips have been flattened out to almost nothing. Another anticlinal axis, well marked in Fulton Co. to the east of the Broad Top anticlinal, limits the eastern extension of the long and narrow *Ray's Hill synclinal*, which extends for 8 miles into Huntingdon Co. as a narrow canoe-shaped basin, almost totally devoid of merchantable coal.*

The Carboniferous Rocks. The following generalized section of the Carboniferous rocks in the Broad Top region, as far as ascertained, is given on page 59, Report T 2:

Broad Top General Section.†

*Various cross-sections in the Broad Top field are given on plate 398, together with a vertical section of the rocks exposed in the Big Trough Creek basin.

† Although this section fairly well represents the sequence of the coal beds and the character of the rocks intervening between them, a moment's inspection of the plate of compiled vertical sections by Mr. Fulton, already referred to, will serve to show how much at fault an observer

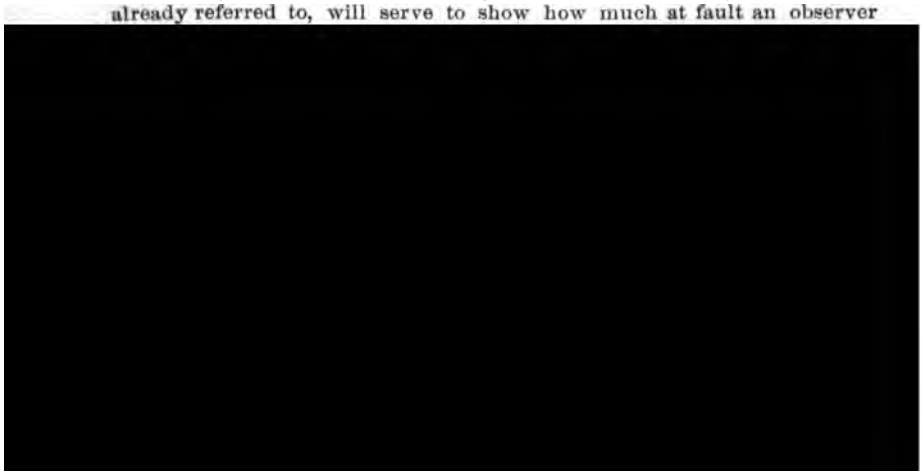


PLATE 397.

N° XIII. Broad-Top District (cont'd)

Comparative Columnar Sections in Blair, Huntingdon & Bedford.

By Jno. Fulton. 1877. Report T3

Allegheny River or Lower Productive Coal Series.



Up. Barren Measures No. XVI.	1. Not exposed; top of Round Knob,	100′
	2. *Coal bed*, seen,	1′4′
Mon. River Series No. XV.	3. Not exposed,	40′
	4. Limestone,	12
	5. Concealed,	200′
	6. *Coal bed;* blossom, said to be,	5′
Pittsburgh Sereis No. XIV	7. Ill-exposed,	425′
	8. Sandstone,	50′
	9. *Speer coal bed*,	1′-10′
	10. Clay,	3′
	11. Sandstone,	40′
	12. Shale,	0′-10′
Lower Productive or Allegheny River Coal Series. No. XIII	13. *Kelly coal bed*,	3′10″-5′
	14. Shales and sandstone,	120′-65′
	15. *Twin coal bed*,	1′ 6″
	16. Clay,	2′
	17. Sandstone,	28′
	18. *Barnet coal bed*,	5′-1′ 9·
	19. Clay,	9′-3′
	20. Sandstone and shale,	50′
	21. *Cook coal bed*,	6′-2′
	22. Clay,	3′
	23. Pottsville sandstones: *Conglomerate Series No. XII.*	

point of the greatest interest in the geology of Pennsylvania as tending to extend the great coal field of the western portion of the state very far east of its present limits and to indicate the enormous erosion which all centra- Pennsylvania has suffered since the Appalachian uplift.

The *Barren Measures*, including the great *Mahoning Sandstone formation*, would be represented by the 520′ of shale and sandstone interval between coal No. 6 of the section and the Kelly coal No. 13, which has likewise been identified as the *Upper Freeport coal* or *Lemon seam* of western Pennsylvania. (Some observers think it the Moshannon or Lower Freeport Bed D of the Clearfield region). This interval is somewhat smaller than it is in the south-western portion of the State and in comparing it with the records of recent bore holes along the Pennsylvania R. R. in the First Bituminous basin west of the Allegheny Mountain, it is certainly less than half the thickness which must be assigned to the Barren Measures in Cambria Co.

The interval No. 7 of 425′ is practically concealed; and though the greater part of it is above the run in the second basin as well as in the Round Knob basin, its exposures are very indefinite and their relationship in the differ. ent sub-divisions of these basins undetermined. Midway in the section occurs a coal bed once prospected on Six Mile run near the eastern edge of the Second (Mt. Equity) basin which has been found by spirit level to underlie the Pittsburgh bed No. 6, by 400′. The whole interval is approximate. The Mahoning sandstone is represented by Nos. 8 to 11 in the section, a total thickness of about 100′, more or less. It is a double for_ mation here as further west, with the thin Speer coal bed No. 9, occuring between the two sandstones.

The *Kelly coal bed*‡ is exposed at several localities on Six Mile run, in the Cunard and Round Knob basins on Long run, and in all five basins on Sandy. It is the mining bed *par excellence* on Sandy, Long and Six Mile runs. Its variations are excessive, both in the number and character of its benches and partings, varying all the way from 5″ to 13′.

At *Mt. Equity* the coal benches from above downwards show 3′ 1″, 0′ 7″, 1′ 2″, 1′ 0″ and 0′ 4″, there being knife edged partings between all these coal benches, with 2′ of clay between the two lower benches. In the *Duval* and *Cunard mines* the bed shows a wholly different structure; an upper bench 2′ 5″ to 2′ 11′ and a lower bench from 1′ 0″ to 1′ 7″, with a parting between of from 3″ to 7″. But beneath the lower bench in the Duval mine there are two thick streaks of clay, 1′ 3′ and 0′ 10″ between which come knife edges of coal, which alone represent the two lower benches of coal in the Mt. Equity mine. The only available coal is in the upper bench, the lower member being worthless at all exposures.

In the *Kemble slope* the whole bed is represented by only 4″ to 16″ of coal; but in the *Round Knob basin* on the same Long run the bed is 3′ 2″ thick, carrying a streak of bone coal 2″ thick about 10″ from the top.

The *Cunard basin* on Sandy shows an upper division for this bed which is concealed along Six Mile run or is entirely absent there. The sections at the *Cambria* and *Harriet*

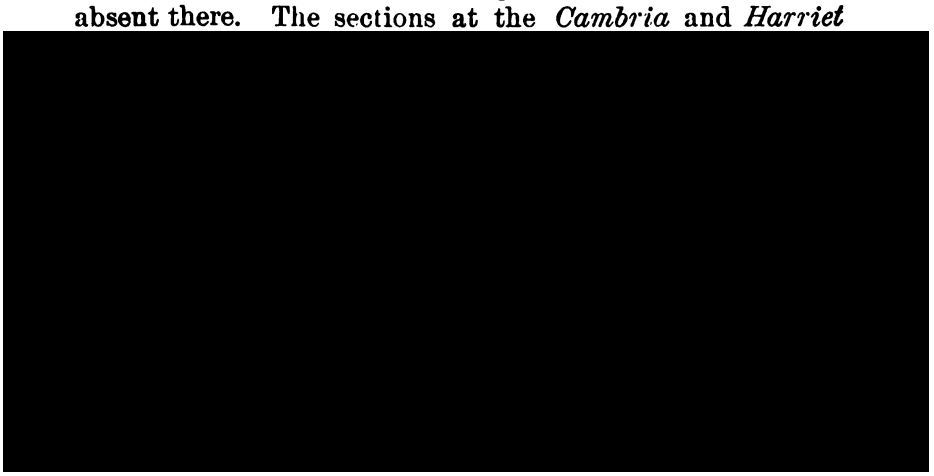


PLATE 388.

No XIII Vertical & Cross-Sections in Broad-Top District

Huntingdon County. Pa

Allegheny River or Lower Productive Coal Series.



This twining is persistent in both of these mines.

Sandy run, in the lower end of the field, forks about a mile from Hopewell, to receive its Long Run branch. There are country banks opened along the west outcrop; but the first operation is at *Langdondale* on Long run, in a basin evidently east of both the Lauder and Mt. Equity synclinals of Six Mile run, where a shaft has been sunk on the eastern slope 245′ deep to reach the Kelly coal bed. In the No. 1 slope first put down on the outcrop no good or thick coal was found, and this opening is supposed to lie in a local basin still further east.

The *Cumberland mine* (Old Cessna mine) is the last operation on Sandy, although there are several intermediate folds or basins between it and Langdondale, each trough eastward being topographically higher and in its basin holding the Kelly coal at less depth beneath the stream. At the *Cumberland mine* the coal was opened on the south side of the creek, immediately in the basin; but the coal has *pitched* southwest for 2000′, compelling a split in the main entry to keep drainage, each entry running towards opposing anticlinals. The basin will undoubtedly spoon up very rapidly before reaching Sherman's valley on the south. The Kelly coal is here 4′ 4″ thick, the mining ply being a rough coal bench 18″ above the bottom.

The *Cambria mine* is only 300 yards distant, but in a separate basin west, with the Chevington and Crescent mines. The entry goes in northeast and connects with the Kearney mine gangways on Six Mile run at a much higher level.

The *Barnet coal bed* has only been developed on the Cumberland property, not being deemed workable on Sandy creek, and elsewhere westward under considerable cover. The top bench alone shows 22″ thick, with 4″ of bone on top.

The *Kearney mine* of the Everett C. & I. Co. on Long run, besides connecting southward with the Cumberland, has been extended 3000′ northward, where the Kelly coal became too impure for profitable work. The bed in this mine shows a slate roof; coal 1′ 10″; mining ply 0′ 4″ of

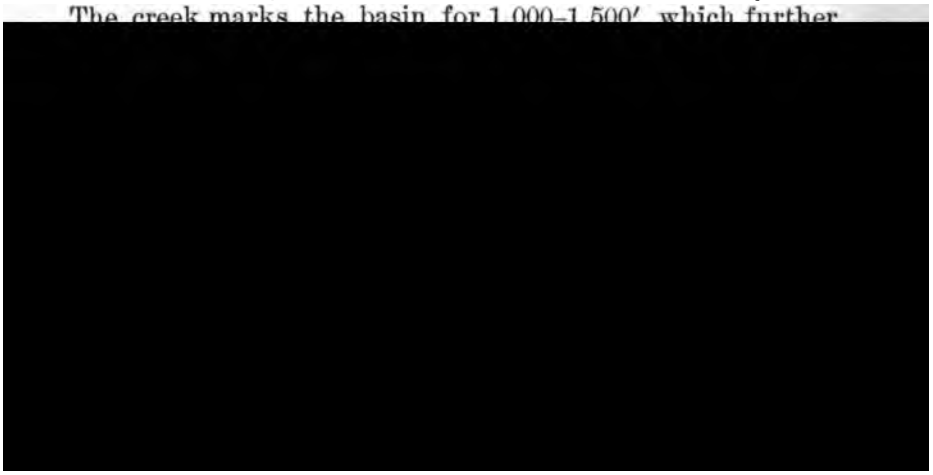
rough coal; coal, good 1′ 7″; black slate 0′ 1″; bottom coal, poor 1′ 3″. Total 5′ 1″. The bottom coal is good on Sandy, poor on Long run and worthless further north, with many local rolls.

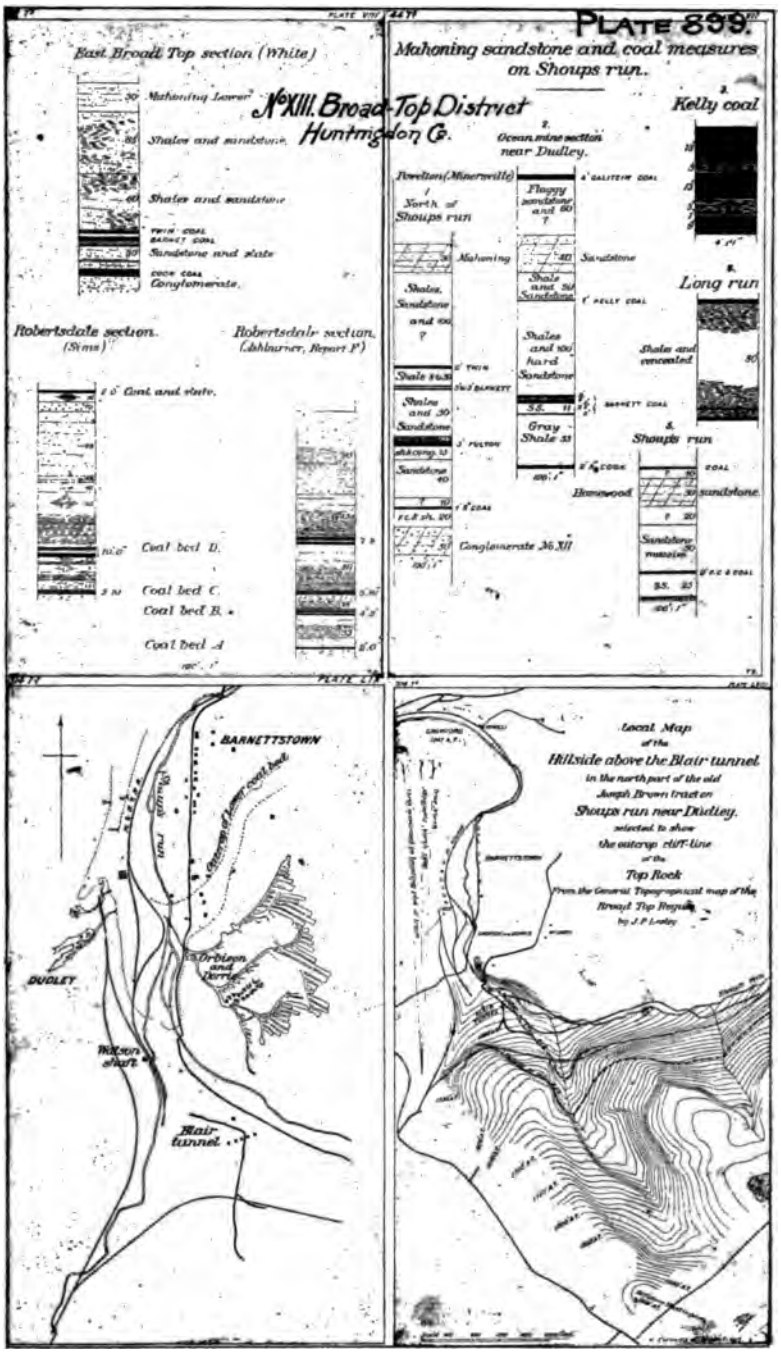
On Six Mile run, the *Fulton* or *Cook seam* was worked actively during the war at North Point. The *Barnet seam*, 2′ 4″ thick, was also mined at the old McIntyre (Maher and Baumgardner) opening.

The *Kelly seam* is first seen in next (Cunard) basin west, the bottom of the basin in this coal being about 25′ above creek. A shaft 90′ deep here reaches the Barnet seam as well. The measures decidedly sink south-west and most of the coal is worked out. The west entry was largely in poor coal; the east entry in good coal. Recently a slope has been driven southwest directly down the trough of the basin, developing many rolls.

The Shriver's Run railroad switch reaches the Kelly coal here well up the hill side to the southwest. The *Fairplay basin*, next west, carries a deeper area of the Kelly seam, developed by the Chester Wilson slope on the west leg of the trough, a small and low anticlinal separating it from the next (Duval) basin, where there is an 80′ shaft on the Kelly bed.

Finally the *Brown basin* is next reached, 2000′ wide between the boundary anticlinals on Six Mile run, where there is still a good but deepened area of the Kelly coal. The creek marks the basin for 1,000–1,500′ which further




PLATE 899.
East Broad Top section (White)
No XIII. Broad Top District
Huntingdon Co.
Mahoning sandstone and coal measures on Shoups run.
Kelly coal
Ocean mine section near Dudley.
Long run
Shoups run
Robertsdale section. (Sims)
Robertsdale section. (Ashburner, Report P)
Coal bed D.
Coal bed C.
Coal bed B.
Coal bed A
Conglomerate No XII
Brimwood
BARNETTSTOWN
DUDLEY
Wilson shaft
Blair tunnel
Local Map of the Hillside above the Blair tunnel in the north part of the old Joseph Brown tract on Shoups run near Dudley, selected to show the outcrop cliff-line of the Top Rock
From the General Topographical map of the Broad Top Region by J. P. Lesley



and gangways carried over the west anticlinal into the adjoining Lauder basin, which has been developed 800′ down the slope and furnishes excellent coal 4′ 6″ thick. The *Conglomerate measures* are exposed towards Riddlesburg, and both the *Barnet* and *Fulton coals* are thin on the western outcrop.

Along Shoup's run in Huntingdon Co., the next section north, and east of Saxton, no less than five independent basins have been developed, with several subordinate rolls approaching the Broad Top mountain on the east; but the Kelly coal is only 6″ to 15″ thick, and the developments are confined entirely to the Barnet and Fulton beds (See sections on plates 399, 400 and 401).

The third and fourth troughs (or *Powelton* and *Dudley basins*) are the most important, and extensive mines have been opened on both the lower coals at the Benedict and Powell mines; by Reade Bros; at the Huntingdon Nos. 1 and 2 of Messrs. Sweet and Brown; at the Ocean mine and the Moredale mine towards Broad Top city.

The interval between the Kelly and Twin beds varies greatly. On Six Mile its thickness is from 188′ in the first basin to 75′ in the Cunard basin; on Sandy it is but 65′, and is sometimes all shale and sometimes largely sandstone.

The *Twin bed* is unimportant, rarely exceeding 18″ in thickness, but without parting; but it is a useful guide.

The *Barnet coal* bed is exposed at many places along Six Mile run, but on Sandy creek only in the Cumberland or Cessna basin. The interval between it and the Twin bed is extremely variable, especially on Six Mile run in the First basin, where it is 7′, 19′ and 37′ in a distance of 200 rods. In the Cunard shaft it is 30′, but only 17′ on Sandy below the mouth of Long run; interval sandstone. The Barnet bed varies like the Kelly seam. It is from 2′ to 5′ thick in the *First basin* on Six Mile run and shows in the Cunard shaft, two coal benches 2′ 8″ and 0′ 10″ thick, separated by from 6″-18″ of shale and on top carrying from 3″-10″ of bone coal. In the *North Point basin* the bone coal shows 3″ to 4″ thick; but the bed here shows but a single bench from 1′ 6″ to 1′ 10″ thick. In the *Round Knob basin* it has the

same structure, but the bone coal is 6″ thick and the good bench 3′ 6″. The bone coal on top seems to characterize this bed everywhere as it is as well marked at the Wishart mine in Fulton Co. as in the First basin on Six Mile run. Fire clay, 3′ to 9′ thick, underlies the Barnet bed, containing kidneys of clay iron-stone.

The *Cook bed*, No. 21 of the section, occurs from 8′ below the Barnet bed in the Cunard shaft to 50′ on Sandy run and in the North Point basin; clay and shale at the former, but sandstone on Sandy run. The coal varies from 2′ 0″ to 2′ 6″ in the First basin on Six Mile, its section in the Cunard shaft showing two benches of coal, each 18″, separated by 6″ of clay. At a shaft near North Point the coal is represented by carbonaceous clay, while a short distance beyond it is said to reach a thickness of 7′, and at one time was worked on Sandy, nearly 3′ thick. (See plates 399, 400 and 401.)

It is these excessive changes of character in the coal beds of the Broad Top field and the equally great variation in the interval between them which has militated largely against their being mined with economy and being identified with certainty in exploration. The basins carry many rolls; spoon out along line of strike, but pitch generally southwest.*

* The *First Broad Top basin* crosses Shoup's run near the saw mill below Coalmont. It is too shallow to hold any coal above the conglomerate until it passes south into Bedford Co. where it contains the Cook and Barnet coals; and when it reaches Six Mile run it holds the Kelly coal of the Kemble Coal Co.

The *First anticlinal* is scarcely appreciable on Shoup's run, giving a

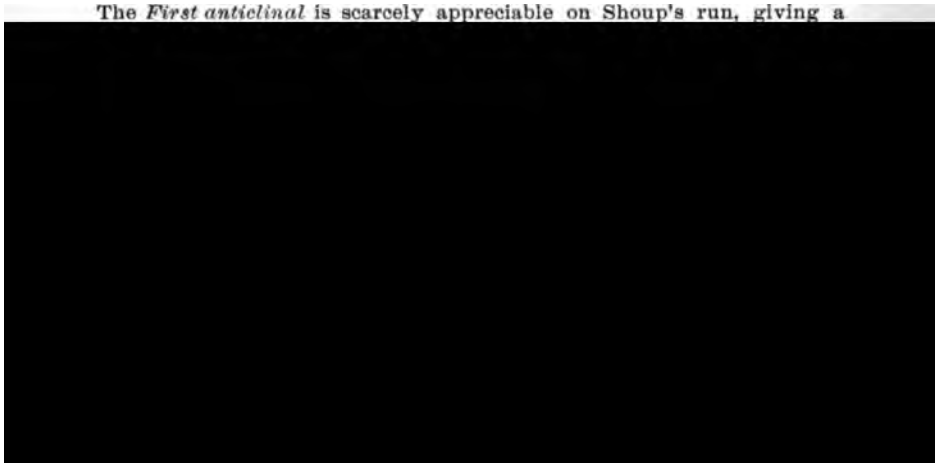


PLATE 400

No XIII Sections of the Twin, Barnett & Cook Coal Beds

Broad-Top District Rep T3



In Huntingdon Co. a small area of the coal measure rocks occurs, confined entirely to Carbon twp. along the Bedford line.

The Mahoning sandstone consists of two well defined members, as in Bedford Co.; the upper 50′ to 60′ thick, sometimes flaggy or even shaly and the lower 25′ to 30′ thick, a massive gray rock, filled with white quartz pebbles. It occupies a small patch above the shaft of the Rock Hill Coal Co. in the East Broad Top coal field and is also caught in the Rocky Ridge synclinal.

The *Speer coal bed* is nowhere of workable size in Huntingdon Co., having thinned away coming north from Bedford, and may be considered practically absent from the section. It is however claimed to have merchantable thickness west of the new Woodvale shaft in Trough creek, on the summit of Broad Top mountain; but no openiugs have been made on it.

The *Lower Productive Coal Measures* show some important changes in this county also, the most important, from an economical standpoint, being the almost complete thinning away of the Kelly coal bed of Six Mile and Sandy runs in Bedford Co., thus leaving the Huntingdon Co. coal area with only two workable coal beds instead of three or four.†

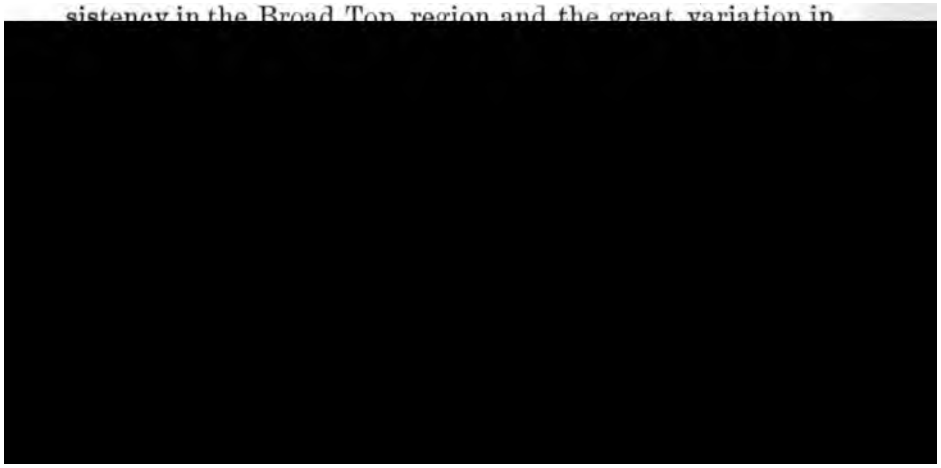
coal nearly down to water level. The bed rises at an angle of from 10° to 15° out of the basin and soon gets to be 200′ above the creek. The basin is rising northeastward at the rate of about 2½′ in a hundred, and in many developments on the Barnet coal bed it was found that the rolls or flexures of the rock, however slight, were remarkably persistent and approximately parallel, with a general direction of N. 35 E. (For a discussion of the many interesting features of this district see report T 3, page 307).

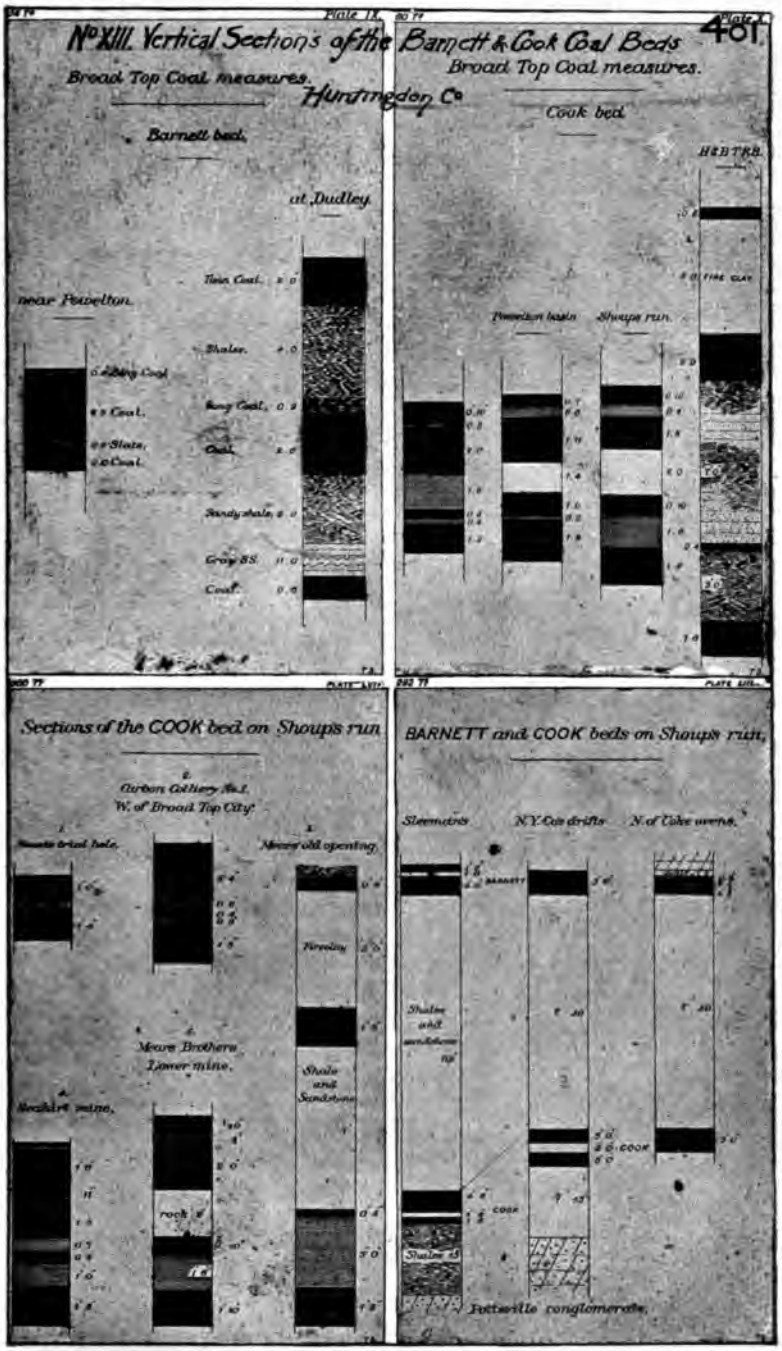
The *Fourth* (Dudley) *basin* lies a short distance up Shoup's run from Powelton station, a ridge of conglomerate forming the axis between it and the Third basin, carrying the Barnet coal over the crest of the arch a half mile north of Shoup's run, where it has been mined extensively by Reed Bros. The Dudley basin passes directly through the town of Dudley, its center line crossing the railroad 100′ west of the depot and just west of the Catholic church. It seems to be the basin of Fairplay on Six Mile run and of Round Knob. It is deep enough to carry the Barnet bed below the level of Shoup's run at Dudley and puts several hundred feet of overlying measures into the hills south of the town. Nevertheless its bottom line is not as near sea level as that of the Powelton basin by 175′.

† As was supposed prior to Report T 3. Vertical sections at *Minersville* (Powelton basin) and at the *Ocean mine* near Dudley are given in T 3, page 44, as well as local sections on Long and Shoup's runs. See plate 399 of this report.

The *Kelly coal* thins away somewhere between Six Mile run and the Huntingdon Co. line, in a distance of only 3 or 4 miles, so that only a trace of this coal bed has been found in the latter county, though it has been sought for with shafts and drifts at many localities. This fact, until it was discovered, brought about further difficulties in the identification of the measures in the two counties. The bed is cut by the Ocean Mine tunnel about 30′ under the lower Mahoning sandstone and 100′ above the Barnet bed; but it is only 8″ to 12″ thick*. The *Twin coal bed*, separated by 2′ to 30′ of rock from the Barnet coal below, shows the same clean, dry, open burning bed in Huntingdon as it does in Bedford Co.

The *Freeport sandstone group*, below the Kelly group, shows a series of sandy shales and shaly sandstones, which often thicken up, especially in the lower part, into a rather massive gray sandstone, well exposed opposite Dudley. At the Ocean mine the top portion is shaly and the bottom mostly a hard sandstone, the whole interval from the Kelly bed to the Twin bed being about 100′. This interval contains no coal, so that if the Kelly bed be the Freeport upper, then the Freeport lower coal would seem to be absent throughout Huntingdon Co. The Twin coal bed is a very persistent stratum, so called as it often occurs only a foot or two above the Barnet bed, when it is mined as a part of the latter seam. It is remarkable for two things: its persistency in the Broad Top region and the great variation in




Plate IX.
No XIII. Vertical Sections of the Barnett & Cook Coal Beds
Broad Top Coal measures.
Huntingdon Co
Barnett bed.
at Dudley.
near Pexelton.
Broad Top Coal measures.
Cook bed.
Pennsylvania basin
Shoups run.
Sections of the COOK bed on Shoups run
Moore Brothers Lower mine.
Shale and Sandstone
Rockhill mine.
BARNETT and COOK beds on Shoups run.
Sleemakers
N.Y.Co drifts
N. of Coke ovens.
Shales and sandstone
Pottsville conglomerate.



a hard clean seam, seldom more than 2½′ thick and hence only workable when in conjunction with the Barnet*.

The *Barnet bed* was named from a mine in the vicinity of Barnetstown, just below Dudley. Much more coal has been mined from it in Huntingdon Co. than from any other seam, especially in the Powelton and Dudley basins; while in East Broad Top it, in connection with the Twin bed above, is the only one mined to any extent.

In contra-distinction to all all other beds of the Broad Top region it carries a top layer of bony coal, 4″ to 6″ thick, which seems never absent. The rest of the bed is often divided into two portions by a layer of slate or shale, 2″ to 12″ thick, just above the center. It was extensively mined by R. H. Powell at the Scott mine and by Reed Bros. a short distance above Powelton in whose mines the coal exhibits the following structure in different parts of the colliery:

	A.		*B.*		*C.*	
Bony coal,	0′ 6″		0′ 4″		0′ 4″	
Coal,	3′ 8″		2′ 6″		2′ 8″	
Slate,	0′ 10″	6′ 9″	0′ 8″	4′ 4″	0′ 6′	4′ 4″
Coal,	1′ 9″		0′ 10′		0′ 10′′	

In the *Ocean mine*,† operating this same Barnet bed, there is a very abnormal condition of affairs, as evidenced by this section:

*In the Powelton basin the interval between these two beds varies from 8′ to 30′. The upper bed has been mined only to a limited extent on the Powellton property. Eastward this interval thins so that in the Dudley basin it rarely exceeds 6′ or 8′, where the thickness of the Twin bed is only 1′ to 1½′. At the Ocean mine the interval thins down still further in certain parts; but in the same mine it increases again to 8′.

In the Fisher colliery above Moredale this bed was generally mined with the Barnet, except where the interval rocks had a thickness greater than 3′. At the Robertsdale colliery, in the East Broad Top field, the parting rocks vary from 6″ to 7′ thick; but the Twin bed usually occurs on top of the Barnet seam and is taken out with it.

† The coal from the Ocean mine is highly valued as a locomotive fuel, although it carries a considerable percentage of both sulphur and ash. The Cook or Fulton seam, which lies below, has never been mined to any extent along Shoup's run.

Coal, "Twin,"			2′ 0′′
Shales and rock,			4′ 0′′
Barnet coal,	Coal bony,	0′ 9′′	17′ 9′′
	Coal,	2′ 6′′	
	Sandy shale,	3′ 0′′	
	Gray sandstone,	11′ 0′′	
	Coal,	0′ 6′′	

This section is a good illustration of the great irregularities which are found in every extensive coal mine in the Broad Top region, viz: the local thinning and thickening of the shale partings in every coal bed except the Twin seam.

At Broad Top City the *Barnet coal* is only a few feet below the surface. Mr. White considers the Barnet coal in the Broad Top field to represent the *Lower Kittanning bed B* of western Pennsylvania, for the following reasons: *1st.* Its place in the section i. e. the lowest workable coal but one in the Broad Top section. *2d.* The structure of the coal itself, especially the peculiarity of carrying a few inches of cannel or bony coal on top.

The *Cook bed* characteristics are shown by sections in plates 400 and 401. It is separated from the Barnet coal by the Powelton shales, usually 50′ thick in Huntingdon, though reduced to 25′ at Robertsdale in the East Broad Top basin and to a much less thickness in Bedford Co.* As a further identification of this seam, its roof shales are very fossiliferous, containing immense quantities of fossil plants especially ferns; and this characteristic is confined almost solely to the horizon of this coal bed in the Broad

are found attached to the roof shales of this coal; but nowhere were molluscan or other animal remains of any description found.

The structure of the coal has everywhere the same general appearance on Shoup's run. At the original Jesse Cook bank and at the Mears Bros. mine on the south side of Shoup's run ½ mile below the Cook opening, the entire bed shows a thickness respectively of 6′ 6″ and 8′ 8″; but at both places its integrity is seriously spoiled by slate partings, of which there are three at the Cook bank 0′ 3″, 16″ to 20″, and 0′ 4″ thick, with the bottom bench of coal 14″ thick, so slaty and sulphurous as to be worthless. The coal benches are 10″ on top, 2′ in the middle and 5″ thick in the lower. At Mears' the top coal is 2′ 10″ thick, carrying from 2″ to 6″ of bone 10″ below the top. Beneath it there is a rock parting 2′ thick, the middle coal bench 10″; a gray slate parting 1′ 6″ and a lower coal bench 1′ 6″. Hence this bed may be regarded as a triple seam, with the main body of coal in the upper bench; a middle bench, always pure but never more than a foot thick and often less; and a lower impure bench which varies from 1½′ to 2′. The partings are subject to astonishing variations in thickness and sometimes swell to such a degree as to make the entire bed section run up to 20′; containing little more coal however than when it is one-third that thickness. The main parting is known to vary from 4′ 0″ to 25′ 0″.

In the *Powelton basin* the Cook coal has been extensively mined by R. H. Powell's Sons & Co. and shows the following structure:—

Coal, upper bench,	Coal, . . 0′ 7″ Bony coal, 0′ 5′ Coal, . . 1′ 11′	2′ 11″	7′ 2′
Rock,		1 4″	
Coal, middle bench,		1′ 0″	
Shale,		0′ 2′	
Coal, lower bench,		1′ 9″	

Of course in other parts of the mine each of these subdivisions shows variations in thickness, the slate parting being frequently from 6″ to 10″. The rock parting is ex-

cessively hard, which renders the mining of the Cook bed* in Huntingdon Co. difficult and expensive.

East Broad Top Coal Field.

The Broad Top anticlinal divides the Broad Top coal field into two well defined portions, that east of the axis (including the long and slender basin of Ray's hill and Rocky ridge) being included in the *East Broad Top coal field*, drained by Trough creek.†

The *Mahoning sandstone* caps the hill northwest of Robertsdale, consisting of a white conglomerate sandstone, in two divisions, between which lies softer shaly sands and shales, containing a thin coal bed; the whole 90′ thick. The coal measures beneath it are 166′ thick and consist of shales, slates and sandstones, containing three workable seams of coal of two benches each. The precise intervals

*Analyses of this coal are given in full in report T 3 on Carbon twp. The coal has been coked at Powelton in Belgian ovens and was formerly mined extensively by the Reakirt, Fisher and other collieries, the bed having a far greater outcrop than any of the others owing to its position nearly down on the Pottsville Conglomerate No. XII. It has been found in a small patch on Shirley's Knob but much broken and crushed, in a bed from 5′ to 7′ thick.

†This eastern portion of the field was described and reported upon by the late Charles A. Ashburner as a portion of report F, 1874 and 1875, and to a limited extent in report T 3, by I. C. White.

Mr. Ashburner gives a detailed section of the Lower Productive Coal Measures, including the Mahoning sandstone, or "top rock" of the Broad Top miners. report F, pages 185 and 186, to which he assigns a total thickness of 256′.

Prof. White, in report T 3, on Huntingdon Co., gives sections on pages 46

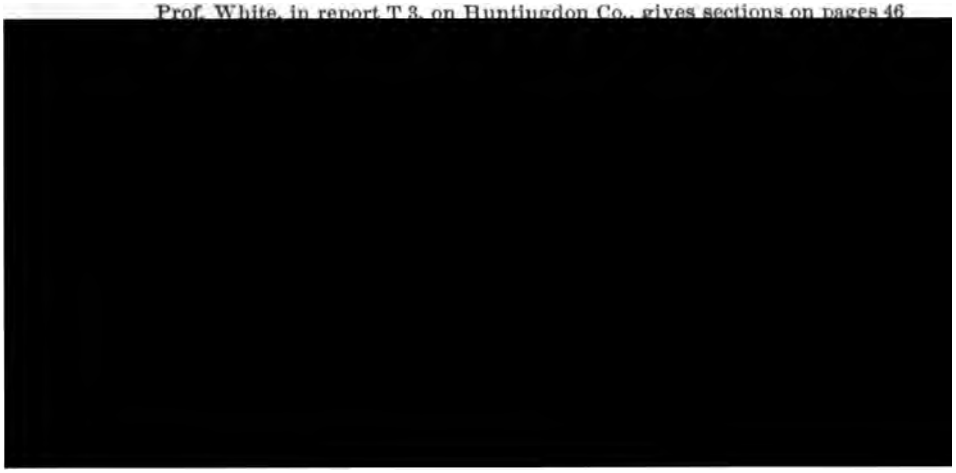


PLATE 402.

Allegheny River Coal Series.

No XIII. East Broad-Top. Vertical Sections. Huntingdon Co.

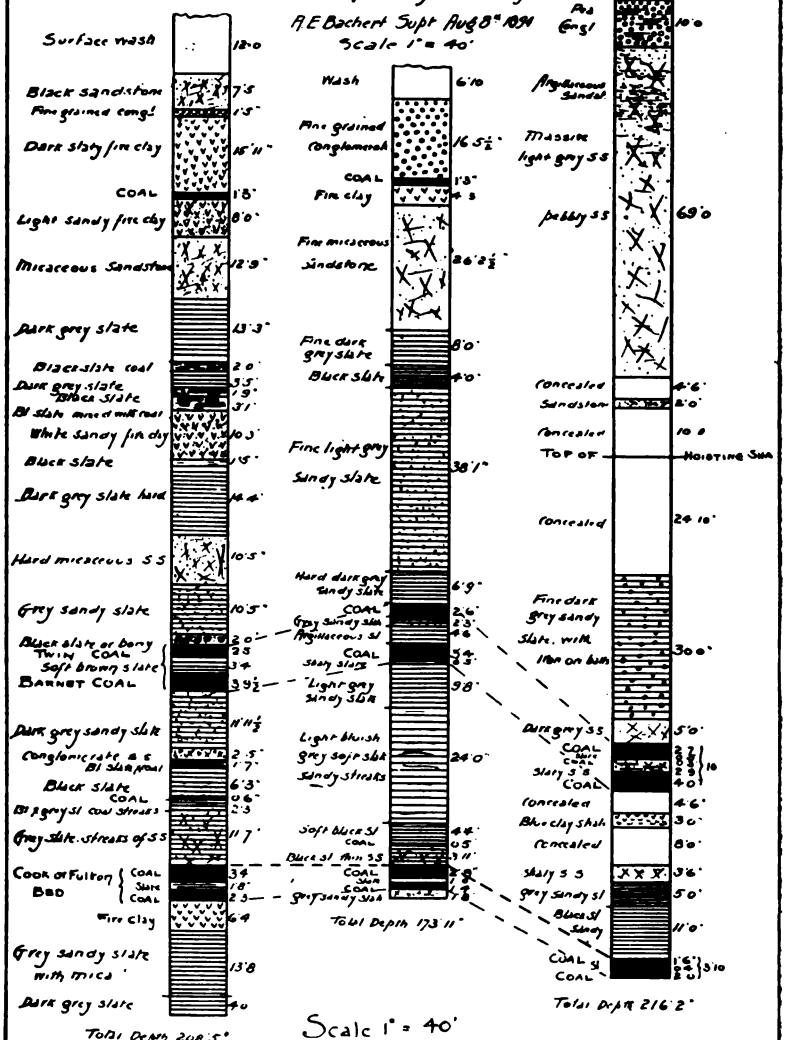
1 Woodvale Shaft No 19 Bore Hole. Elev top of shaft 1855.5

2 Bore Hole No 1 Elev. 1848.5 ?

3 Robertsdale Shaft: Compiled at the 183 Adits

Sections plotted from data of A.E Bachert Supt Aug 8th 1894

Scale 1" = 40'





between these coal beds at Robertsdale were as difficult to determine as in the main Broad Top basin in Bedford Co., owing to a number of rolls in the strata and the want of accurate levels.

The *Big Trough Creek coal basin* is very shallow, and its rocks nearly horizontal. It is an elevated plateau with coal terraces faintly marked. Of the three coal beds shown in the section, plate 398, locally known as beds B, C and D, only the two former have been developed to any great extent in this basin at the *Robertsdale Colliery* and at the *Alloway openings* on the Anderson property, about one mile distant from Robertsdale.*

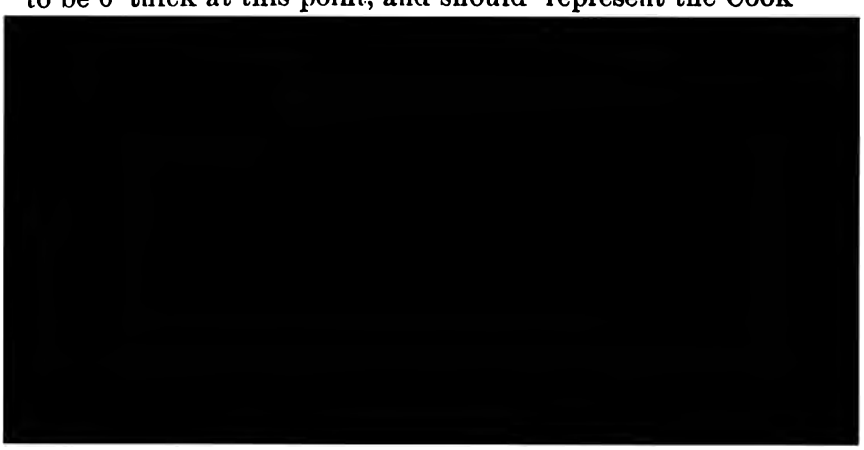
For coking purposes, the coal of the East Broad Top basin hardly contains a sufficiently high percentage of volatile matter, although a considerable amount of coke has been manufactured in the past in the Belgian and Bobiet ovens, which yielded about 10% of ash and 1½% of sulphur. A sample of both benches of the coal mined at the Alloway opening contained 4% more fixed carbon, 1½% less volatile matter, .45% less sulphur, and 1.75% less ash than an average specimen from both benches from the same *bed C* at Robertsdale. A further indication of the chemical character of these East Broad Top coals may be had from samples taken from unidentified beds in the *Rocky Ridge basin*, at the *Curfman* (Savage) *opening;* the *Petriken* (Taylor) *opening* and at the *Dougherty opening.* The two former are closely alike, showing about 18% volatile matter; 75% fixed carbon, .8% of sulphur and 5% of ash; but the Dougherty coal shows about 1½% of sulphur and 13½% of ash.

In the *Rocky Ridge basin* the Cook bed is supposed to have been opened at the Sleeman bank where it obtains a development unequalled at any other locality in Huntingdon Co., showing here as two coal benches only, 4½′ to 5′

* A suite of analyses were made of the coal from both benches of these two beds, reported in full in F, page 188, which show very great uniformity in the character of the coal, except in the sulphur constituent, which varies from 1.115 to 4.170. The volatile matter is very constant in eight different analyses, from 14.30 to 16.21. Fixed carbon ranges from 70.601 to 77.150 and ash from 6.97 to 9.232, with an average of about 8%.

thick and 1′ 6″ thick, divided by a foot of shale, giving nearly 5′ of good clean coal in a single bench. This coal was personally sampled in October, 1891, where it showed the face 4′ 6″ to 5′ 0″ thick and yielded upon analysis, fixed carbon 73.050, volatile matter 17.886, sulphur .975 and ash 7.955. A coal bed 2′ 10″ thick with an inch of bone on top was then being mined as a smithing coal for Rock Hill; but though free from partings, it carried visible sulphur bands and was usually but 2′ 6″ thick. At this point the Rocky Ridge basin, between the outcrops, cannot be over 1,000′ wide, pitching south-west to a pot or center and defined by numerous old pits near the Stapleton house. The *Taylor bank* is an old opening on the eastern rim of the basin about a mile south-west from Sleeman's, where the coal pitches 40° into the basin and averages about 4′ 6″ thick. The coal looks ragged and carries a bad fire clay slate roof; but it is of good quality as is evident from a sample taken at the same time as the Sleeman sample which showed fixed carbon 71 .419, volatile matter 19.636, sulphur .771 and ash 6.150. At the end of the entry the coal was squeezed down to 2′ 6″. The Petriken bank is nearby.

The *Dougherty bank*, still further south on the James Miller tract, was visited at the same time; but the opening was filled in with water since the lapse of the lease in January 1891 to the East Broad Top Co. The coal is reported to be 6′ thick at this point, and should represent the Cook



The *Robertsdale slope* goes down on the Barnet and Twin seams, (C) 35′ higher than the B, and at the pump shaft it is 70′ from the surface to the coal. These two beds, in many parts of this mine, are separated by a small rock parting, the upper (Twin) bed averaging 3′ 6″ of clean coal and the lower (Barnet) bed 3′ 4″ with 4″ of bony coal on bottom, and from 1″ to 4″ of bony on top.

The new *Woodvale shaft* (145′ deep) is situated about one mile south of the slope and strikes the Barnet seam east of the main basin. Gangways driven towards the eastern outcrop all show good coal about 6′ thick, carrying bony on top and about 4″ of bone near center. They rise on about 2° slope for some distance, developing two narrow local swamps and axes where the coal dips 6°, and further east, a dip of 34°. This would enable a short cross-cut to be driven through the measures here to the Cook or Fulton seam below, which always showed a good character in this basin. Vertical sections around Robertsdale are given in plate 402.

To the west of the shaft the coal still dips into a "swamp" and becomes very thin (2′ 6″) and finally in one entry shows only about a foot. On the western leg of the basin additional rolls were encountered and while the general tendency is to pitch south-westward, at several points these local "swamps" spoon out. Owing to the increased interval (6′ to 8′) between the Barnet and Twin seams, the former (averaging about 3′ 2″ thick) is alone worked at present.*

Going up on to Ray's Hill the road crosses the ridge and descends beneath a knob containing the Scott bank, consisting of a strip about 600′ wide and a 1000′ along the ridge, owned by J. W. Scott. The coal is claimed to be 5′ thick with a rock parting; I measured it in two places 4′ 4″ and 4′ 7″. Bottom bench is 1′ 9½″ to 1′ 11″; the partings

*A surface section line was run from the shaft across the mountain to Six Mile run near the south of Anderson run, and from testimony on this side of the basin in the old slope workings, the Barnet seam should cross this axis at least 200′ beneath the ridge summit. It is highly probable that both the *Fulton* (Cook) and *Barnet seams* remain intact under the Broad Top axis south of the public road between Broad Top city and Robertsdale, in passing from Shoup's and Six Mile runs over into the Trough Creek basin.

8″ to 9″ and the top coal 1′ 6″ to 1′ 8″, the bottom bench sometimes showing 2″ of bony coal on top. My sample of both benches showed fixed carbon 71.806, volatile matter 16.711, sulphur 1.869 and ash 9.0.

No. XIII in Sullivan and Lycoming Counties.

Sullivan Co. Coal is the only useful material found in this county and that is confined to the center line of the Northern or Bernice trough ;* chiefly at Bernice in Cherry twp., but also in the hill tops sparingly in southern Fork twp., south of Big Loyalsock creek.

The *Forksville deposit*, sometimes known as the *Mercer lands*, is largely confined to a small patch on the Hurley warrants and is still without railroad communication. The average width of territory between the two opposing north and south outcrops of the coal bed exposed is 125 rods and with a length sufficient to give a total acreage of within 300 acres. The coal examined† in two country banks within 50 yards of each other along the southern outcrop average 3′ in thickness, sometimes divided within 4″ to 6″ of the top by a thin band of slate into two benches; an upper one of about 6″ of soft smithing coal and a lower bench 2′ 6″ thick of somewhat harder coal, with distinct cleavage. The covering nowhere exceeds 40′ and is chiefly a sandstone with some layers of conglomerate near the bottom.

Analyses of the lower and upper benches (G2 page 218)

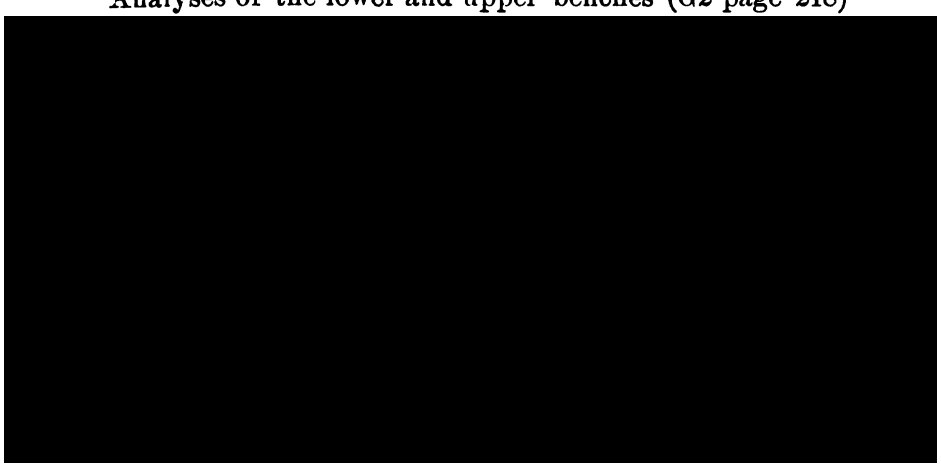


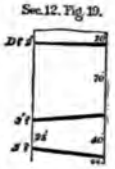
PLATE 403

No XIII Allegheny River Coal Series in Lycoming County.

Coal Sections: Little Pine Creek Basin

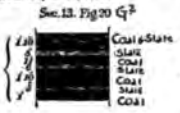
Otter run.

Sec. 12. Fig. 19.



Bed B. Bache Mine

Sec. 13. Fig 20 G^2



Bed B New Mine

Sec. 14. Fig 21. G^2



Bed B English Mine

Sec. 15. Fig 22. G^2

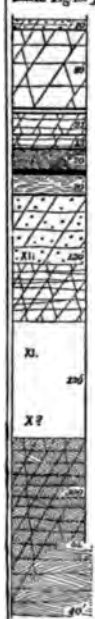


Lycoming Co Cross-Sections

Fig. 16. G^2



Sec. 11. Fig 18. *Little Pine Creek Section.*



Conglomerate.

Sandstone layers, mostly massive; some conglomerate.

3' Coal Bed D. "Double bed"

1' Coal Bed C'.

1'-5'. Bed C.

4½-6'. Bed B. "Big bed" Lower Kittanning

6'-1'. Bed A.

76 Pebbly sandstone. } *Pottsville Conglomerate, XII.*

60 Fine sandstone.

Mauch Chunk red shale. } *XI.*

Pocono Sandstone } *X.*

Catskill. IX.

Fig 17.

Section lengthwise of the Little Pine creek Coal Basin.



Gen'l Vertical Section Lycoming Co

Pine Creek and Four-mile run.



McIntyre Incline Section

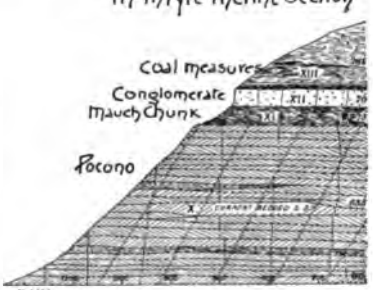


Fig 24.

Pine Creek Coal Basin Lycoming County, Penna.



Fig 25.

McIntyre-Barclay Coal basin shown lengthwise.



DGG.



These analyses indicate a coal half way between the Bernice anthracite and the semi-bituminous coal of Bradford and Tioga Cos., and would be technically classed as a semi-anthracite although *physically* showing all the characteristics of a true bituminous coal. This coal is reported to burn to a fine white ash and should be found suitable for steam and manufacturing purposes, as the small percentage of volatile hydro-carbons would render it desirable for use in large cities where smoke is much objected to. There is an additional patch of quite similar coal further east on the north side of Big Loyalsock creek, where the coal is opened on the Meylert property, showing 2′ 8″ thick at the outcrop. Various other reports of coal being found in other parts of the county have arisen at different times; but all such coal beds are most likely to be found associated with the Pocono sandstone measures and in almost every case where they have been examined, they have been found to be commercially worthless.

Lycoming County. The *Little Pine Creek* and *McIntyre-Ralston basins* are evidently parts of one and the same synclinal axis which, continued to the northeast, would lead into the *Barclay basin* of Bradford Co. The continuity of the field is greatly broken up by the erosion of the various branches of Lycoming and Little Pine creeks, whilst Pine creek near the western edge of the county, creates a complete geographical and geological break between the Pine Creek basin and the long spurs, crested with the Lower Productive Coal Measurs, along the Clinton Co. line to the west.

The *McIntyre basin*,* like the Barclay trough, is canoe

* Various vertical sections of the coal measures in this basin are given in report G 2 and in plates 403 and 404; but perhaps the most complete and representative is that furnished by the late Mr. George H. Platt, formerly chief engineer of the McIntyre Coal Co., figured on pages 124 and 125 G 2, and showing most satisfactorily the sequence and character of the rocks and their coal beds, from which it may be inferred that the *Lower Productive coal measures*, from the higest hill tops in the centre of the basin down to the top of the massive conglomerate sandstone are 269′ thick and the *Conglomerate*, massive and with quartz pebbles the size of a pea, 70′ thick. The Mahoning sandstone 60′ to 65′ thick, at the top of this section, is about half conglomerate, half flaggy and shaly yellow sandstone, with one small layer of black slate.

shaped; a roll or swelling of the whole bottom of the synclynal axis comes in between the two coal basins and, for a broad area, near the Bradford-Lycoming-Sullivan Co. line, the Pottsville conglomerate and Lower Productive coal measures are entirely cut out even from the centre of the synclinal axis. As a basin carrying coal measures it is about 15 miles long and 3 miles wide, although made up of a number of detached coal areas.

The *McIntyre coal bed*, known locally as "Coal E" long before any attempt had been made to correlate it with the Upper Freeport coal of the Allegheny River series, occurs immediately under the Mahoning sandstone. It is opened in numerous places by the McIntyre Coal Co. and varies greatly in size as follows:

McIntyre Coal bed, E.		*Averaging.*
Coal and bony coal,	1′ 0″—2′ 0″	1′ 6″
Coal,	2′ 0″—4′ 0′	3′ 0′
Bony coal and slate,	0′ 0′ —0′ 3″	0′ 3″
Coal,	0· 6″—1′ 0″	0′ 10″

The actual merchantable coal to be won from the two benches necessarily varies in like proportion. In June, 1879, it was somewhat less than 3′; but one small area yielded nearly 7′ of clean coal, although the basin will hardly average 4500 tons to the acre. The coal is a deep black seam; generally free from slate and pyrites and carrying mineral charcoal.* It is doubtful whether this upper seam extends east of the first branch of Rocky run. On Red run however it has been opened west of Lycoming creek 170′ above

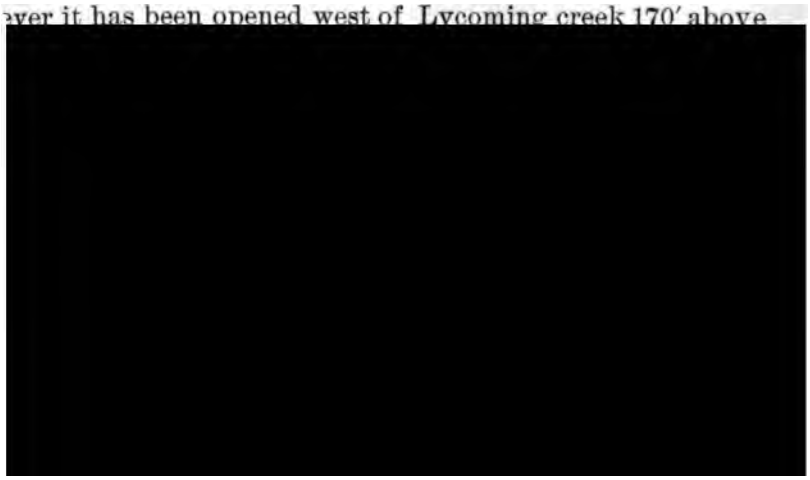


PLATE 404

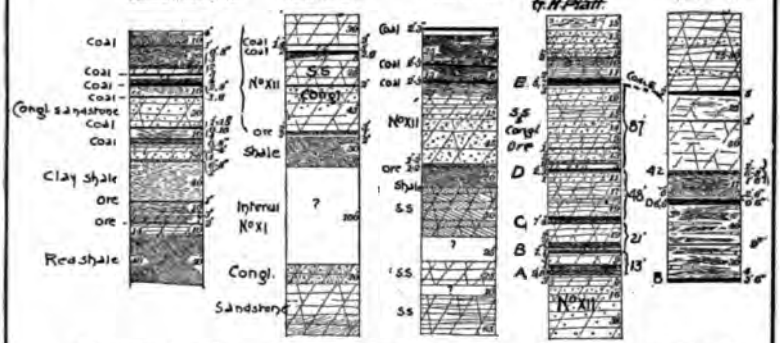
No XIII Allegheny Coal Measures in Lycoming County, Pa

Vertical Sections of the Lower Prod. Group.

Scale 200' = 1".

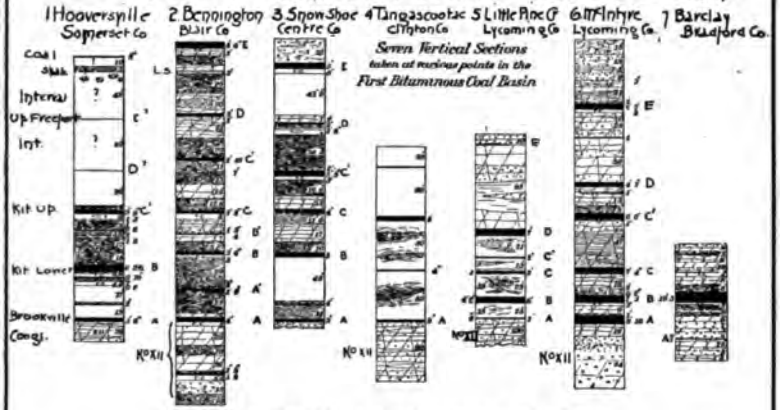
First Geological Survey 1858. Vol. II p. 573. J. T. Hodge

Ralston old mines. | Astonville. | Carterville. | Mc Intyre. G. H. Platt. | Red Run.



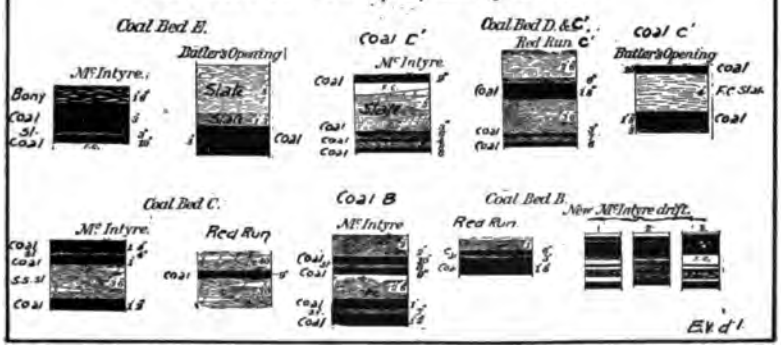
Franklin Platts' Comparative Sections Scale 200' = 1" Pa. Ag.

1 Hooversville Somerset Co | 2 Bennington Blair Co | 3 Snow Shoe Centre Co | 4 Tangascootac Clinton Co | 5 Little Pine Cr Lycoming Co | 6 Mc Intyre Lycoming Co | 7 Barclay Bradford Co.



Seven Vertical Sections taken at various points in the First Bituminous Coal Basin

Detailed Sections of Lycoming Co Coals.



E. V. d. l.



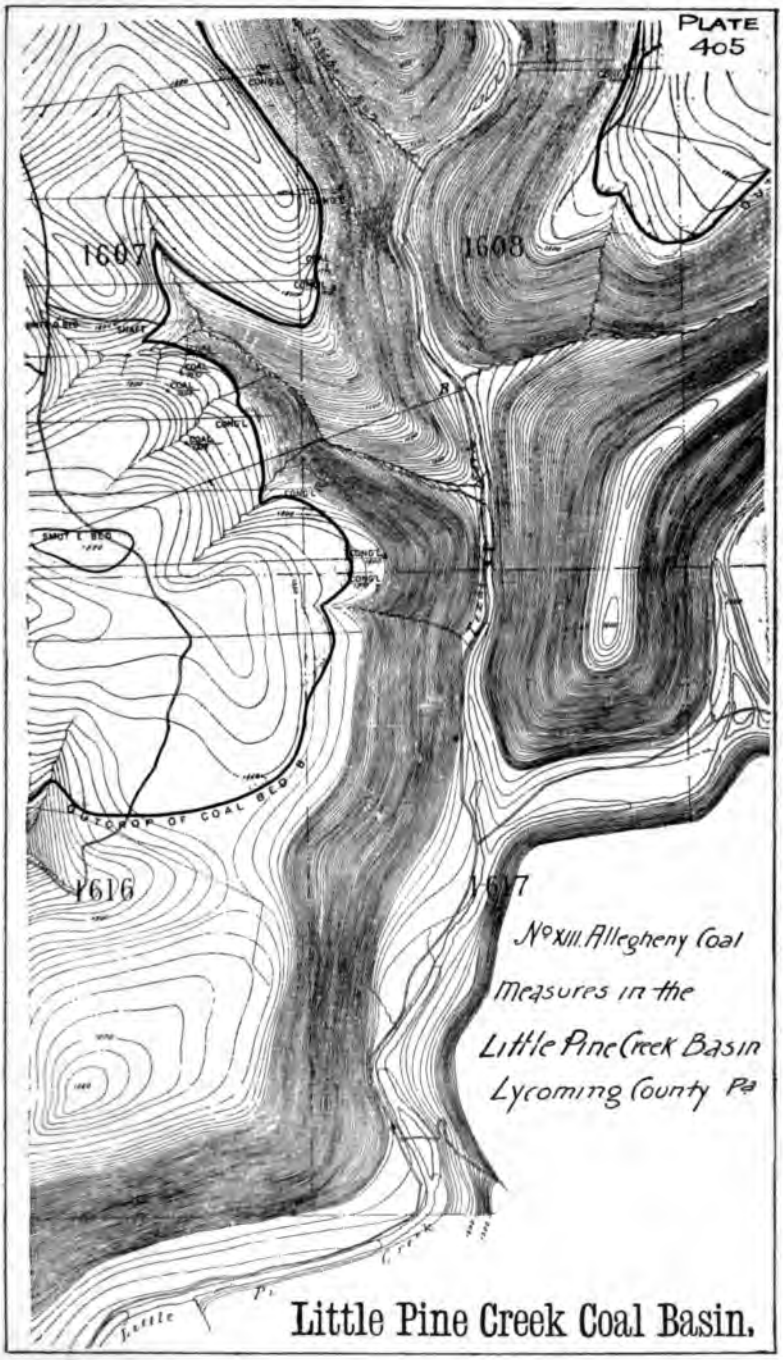
opening of the Red Run Coal Co., this bed merely shows a mixture of slate and generally impure coal varying from 5′ to 11′ in thickness, but everywhere worthless. *Bed C*, the third of the series, is 50′ still lower at McIntyre, the interval being a massive sandstone, partly conglomerate. The frequent occurrence of beds of pebble rock within the Lower Productive coal measures in this McIntyre basin is, to a large extent, unique and were the field of greater extent this fact would be sure to lead to great confusion and uncertainty in the identification of the several coal seams. Coal C is likewise unimportant; for although it shows a section of from 6′ to 9½′ thick at McIntyre, very little of it is coal and a great deal slate and sandstone. It is likewise in poor condition on Red run and has played no commercial part in the development of the region. *Bed B* occurs some 20′ lower, the interval being sometimes a brown sandstone and sometimes dark colored clay slates. For some years this bed was the only coal worked in the McIntyre basin, largely due to the fact of its greater area and accessibility as compared to bed E. The old Ralston mines, the Red Run openings and the Cartersville opening were all on this coal bed B, as well as the McIntyre† and Robinson mines on Rocky run. The bed is thin; for though assigned a thickness of slate and coal of 7′ 1″ in Mr. Platt's section, it will hardly furnish an average of over 2′ of clean coal and rarely exceed 3′. All openings show numerous bands of slate and bony coal and on Red run the bed is reported to show always two benches separated by a thick slate parting. The area of this bed is naturally very great and this fact renders it the most important factor in the history of the coal trade of this region. *Bed A* occurs about 13′ lower than Bed B at McIntyre; but it is a worthless mass of thin layers of coal between thick layers of slate and necessarily has no commercial value whatever.

† Coal from this bed at the new McIntyre opening (1879) yielded upon analysis .782 % of sulphur and 17.950 of ash, while the same bed in the old Carter opening yielded .636 % of sulphur and 9.845 % of ash, so that the chemical character of the coal seems to vary as conspicuously as its bed section.

West of Lycoming creek the McIntyre basin would seem to have a higher value and a brighter future than to the east, although again the branch valleys of Red run and Frozen run cut up this western half as badly as those of Rocky run have destroyed the integrity of the eastern half of the basin. The lower coals catch on the hill tops between the above named creeks along the south side of the basin, which extends west into Jackson twp. 6 or 7 miles from McIntyre. The uppermost (McIntyre) bed E underlies several hundred acres; but the principal acreage is confined to bed B. Numerous old openings show this latter bed to yield between 2½′ and 2′ of coal, but always at the expense of handling a great deal of waste and exercising much care in getting rid of sulphur slate. Naturally such thin coals cannot enter into competition at tide water with the thick coals mined in the Clearfield and Cambria districts or with the Cumberland and West Virginia coals of the South; but in the local New York markets to the north this coal should compete with that of the Barclay basin, with an average thickness of 2½′ to 3′ of coal; the Blossburg basin with about an equal thickness and the basins of northern McKean Co., although the Lake markets are naturally controlled by the more recent developments of excellent beds in Elk and Jefferson Co's.

*Little Pine Creek Coal Basin.**




PLATE
405
1607
1608
1616
1617
OUTCROP OF COAL BED D
No XIII. Allegheny Coal
Measures in the
Little Pine Creek Basin
Lycoming County Pa
Little Pine Creek Coal Basin.



overlying Productive coal measures 155′ to 175′ thick, containing the same coal beds from A to E mentioned in the McIntyre basin. The hill crests are made up of the Mahoning sandstone, here largely conglomerate, as at McIntyre; but the total area of the underlying bed E is too small to have much commercial importance. Coal bed B, or the "Big Bed" of the region, is really the most important and only valuable feature of it. It has been opened at the old *Bache mine* showing a total section of 6′ 11″ with the coal in three benches divided by slate, in all 3′ 8″ thick. This coal yielded upon analysis .656% of surplus and 14.695% of ash with about 20% of volatile matter. At the *New mine* the same benches yield about 4′ of coal; but the slate partings are thicker, the two openings being about one mile apart. The *English mine* on this Big bed, 3 miles north of English Centre, where the bed has 100′ of cover, shows a total of 4′ 3″, still in three benches 1′ 1″, 1′ 1″ and 1 4″ thick, an average of which yielded. 533% of sulphur and 11.325% of ash. From these facts it may be inferred that bed B in this Pine Creek basin is of inferior quality to that in the McIntyre field although the openings had not been developed to any great extent during the period of the examination in 1879. The coal is a semi-bituminous steam coal of fair quality, with a low precentage of sulphur but apt to yield a somewhat high percentage of ash.

The four prominent detached basins in the northeastern end of the Bituminous coal field of Pennsylvania bring about some rather striking comparisons. In the *Bernice basin* the coal of bed E is a genuine semi-anthracite in composition, but not in appearance and fracture, with a ratio of fixed carbon to volatile matter as 1:10.2893. In the *Barclay-McIntyre basin* next north the same coal is semi-bituminous with the proportion 1:4.0939. In the *Blossburg basin*, still further north, the coals are also semi-bituminous but with the proportion of 1:3.4939. Finally in the *Gaines basin*, considerably north in Tioga and Potter Cos., the coals are bituminous with the proportion of 1:1.9643.

No. XIII in Clinton County.

The best areas of the *Lower Productive coal measures* remaining uneroded in Clinton Co. are found in West Keating twp.; near Westport; on the Tangascootack; and at Queen's run, Farrandsville and Eagleton. (See skeleton map, plate 406.)

The *Tangascootack coal field* contains three beds of which only one can be profitably mined, now largely exhausted. This is equally true of the Queen's run and Farrandsville coal fields. The Eagleton mines have had a variable history and while the coal is not nearly exhausted, mining there has been injudicious and in the presence of the superior beds of Clearfield and Cambria Cos., seeking the same market, the demand for the Clinton Co. coal is naturally spasmodic. The small areas near Wetham and on the old Coudersport and Jersey Shore turnpike, though containing a seam 2′ to 3′ thick, have hardly sufficient cover to insure clean coal. The developments near Renovo, between Drury and Shinntown runs, have resulted disastrously. In West Keating twp. some fair coal areas are found between Grove run and Three runs.

The best coal seam* in Clinton Co. is opened near Westport on the dividing ridge between Kettle creek and Little Cook's run. It measures from 4½′ to 5′; is clean, free from slate and shows but a moderate amount of ash and a small

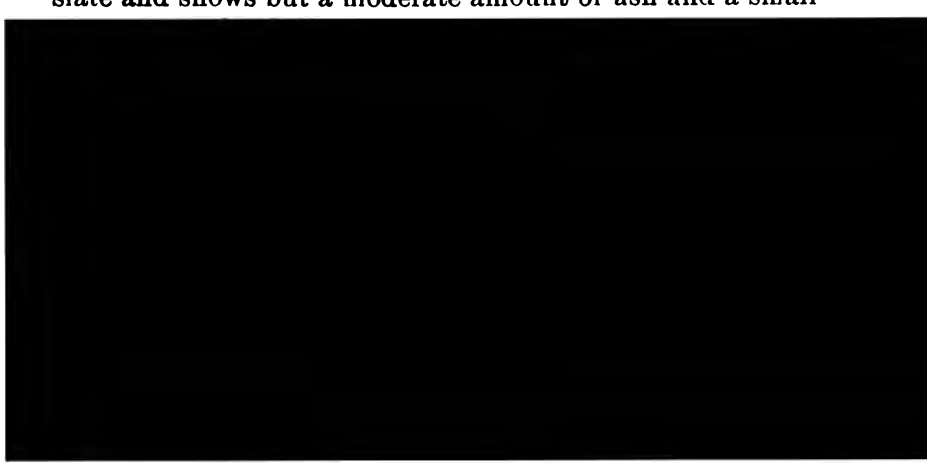
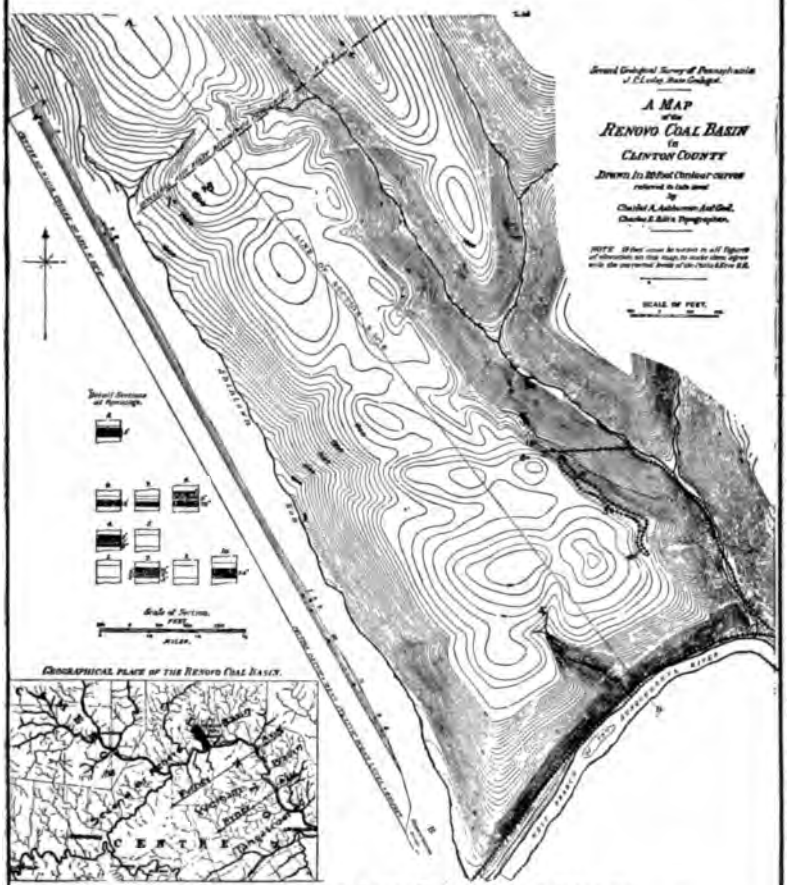


PLATE 406.

No XIII Allegheny River Coal Series in Clinton County





Tangascootack Coal Basin.

This basin is bounded on the south and east by the Allegheny Mountain escarpment, capped by the Conglomerate of XII; on the north and west by the Furney anticlinal axis. Coal has been mined from this region and shipped to market for many years and the vertical section of the measures partakes largely of the character of the Snow Shoe section* of Centre county.

The *upper bed* of coal is the one which has been most extensively mined and shows usually two benches, each 2′ 3″ thick separated by a black slate parting 4″ thick. The coal contains much iron pyrites and it was owing to the failure to separate this material in mining that the reputation of the coal and region suffered. It probably represents bed E or the *Upper Freeport coal* of the Allegheny Mountain series. The *middle coal* 107′ lower, was also opened at the Rock Cabin mines and proved a total failure, varying from 4′ down to 4″ in thickness, owing to the frequent rolling of its floor. It showed the same characteristics at the Irvin and Spering mines, on the south side of Tangascootack creek 1½ miles below the Rock Cabin mines. The *lower coal* 68′ lower, was opened and worked for shipment at the Rock Cabin mines,† but though it showed a good and regular bed, it proved too thin to be worked successfully, ranging from 2′ 0″ to 2′ 6″ in thickness. Like the coal generally along the Allegheny escarpment, it shows a low percentage of volatile matter, 20.845% sulphur, .695% and ash 10.145%.

On the east side of the Susquehanna these coals occur to a more limited extent along streams entering at Queen's run‡ and Farrandsville. The lowest coal bed of the basin,

* G4 page 166, section at Rock Cabin mines.

†It has also been worked 1 mile west of Rock Cabin near Reaville settlement with a small area and only 2′ 6″ thick. At the Peacock mine, one mile west of Rock Cabin, it shows 3′ of coal. It occupies a considerable area in the hill summits on both sides of the creek; but of late years this region has not been very actively worked.

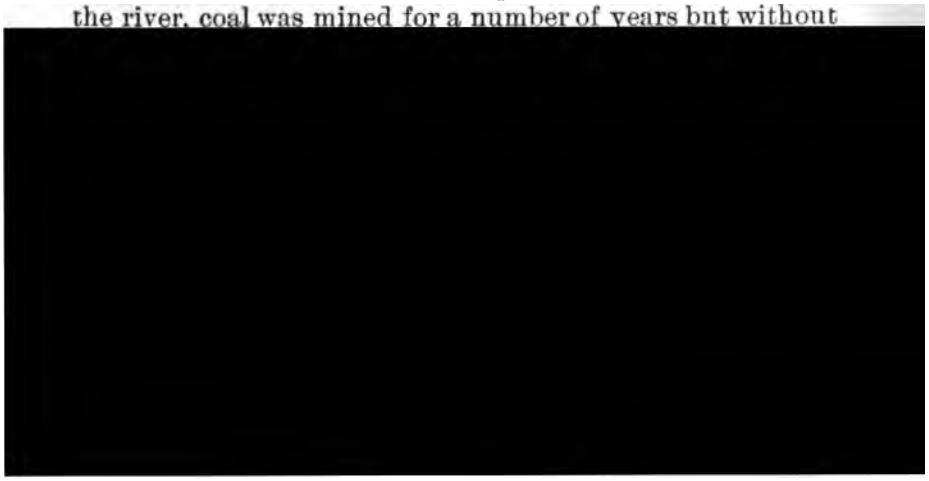
‡A section at this point is given in plate 406 Fig. 2. The lowest bed of coal was worked some 50 years ago for a supply of coal and coke and as measured in the mine showed three benches, averaging 1′ 5″, 0′ 9″ and 0′

as it was mined by the Farrandsville Co. for the use of their furnace on Lick run, showed a section of from 3′ 6″ to 5′ separated by only 9′ 7″ of slate from an overlying coal bed 2′ 4″ thick. The third or top seam, largely eroded from the hill tops, and now nearly exhausted, furnished a better fuel than either of the other two. It has been found to measure in places 6′ thick; but owing to its light cover it has been most largely worked to expose an underlying bed of fire clay from 6′ to 7′ thick of admirable quality.

At Queen's run the same beds of coal and fire clay occur as at Farrandsville; but the uppermost coal is under an ample covering; has a wider area and a thickness from 3′ 9″ to 5′, averaging 4′.

The Wetham Basin.

The Wetham basin, lying next north on both sides of the Susquehanna river, contains very few if any merchantable coal areas, the Clinton Co. map showing but 10 small isolated areas of the Lower Productive measures lying high in the hills along the center line of the trough which here runs parallel with and much closer to the Furney axis on the south than to the Hyner axis on the north. The Hogback ridge along the Jersey Shore and Coudersport turnpike, 3 miles north of Mr. Springer's, contains two lower coal beds, the lowermost probably an inter-conglomerate coal. Their area is very limited and it is doubtful if their coal is commercial. Around Eagleton, on the west side of the river, coal was mined for a number of years but without



The Renovo-Karthaus Basin.

In the Renovo-Karthaus basin* no noteworthy development of coal has been made, although patches of the Lower Productive measures have been left in a number of places in the hill tops fronting the west bank of the Susquehanna river.

The *Karthaus Coal Co.* in Noyes and Chapman twps. expended a large amount of money in development; but the coal beds were found too inconstant in thickness and quality for profitable mining. Coal beds which outcrop with fair thickness were found to thin out to nothing in the center of the hill; and the experience in this respect gained in the vicinity of Renovo was almost unique in the history of mining in Pennsylvania prior to the more recent developments in the Reynoldsville and Dubois basins in Jefferson county.

Westport coal lands lie between Kettle creek and Cook's run. On the east side of the creek a seam of coal 4′ 3″ thick was reported to have been opened, and Messrs. Merriman and Munson have opened a fine seam of bright black coal 5′ thick, on the west side of the creek. It has three partings, averaging 0′ 7″, 1′ 10″ and 2′ 0″ thick separated from each other by thin slate partings. Another opening on the same bed was made later in the bluff overlooking "Short bend" in Kettle creek, under ample cover; but its structure was found to be peculiar, the cleavage planes being very numerous and close together, causing the coal to crumble readily. The chemical purity of the coal suffers

* The *Renovo coal basin* (see plate 406) has been illustrated by a topographical map in report G 4 and several pages devoted to its description by Mr. Charles A. Ashburner. This basin has been regarded as a continuation of the *Second* or *Johnstown basin* along the Penna. R. R. and synonomous with the *Karthaus basin* to the southwest and the *Blossburg basin* to the northeast. A vertical section of the measures above the conglomerate shows five different coal beds, the upper or fifth bed being regarded as identical with the *Dagus bed* of Elk Co. or *Lower Kittanning coal bed B* 4 thick. Coal No. 4, reported 3′ 2″ thick, has been opened on both Drury and Shinntown runs where it shows over 1 % of sulphur and 19 % of ash, underlying about 850 acres. The bed is believed to be the equivalent of the *Clermont coal* in McKean and *Clarion coal* in Clarion Co. The measures below this to the bottom of the section containing three other coal beds have been regarded as representatives of the Pottsville Conglomerate No. XII.

greatly from the presence of an excessive percentage of sulphur, over 2½% in the sample analyzed, which would necessitate careful washing to make it merchantable.*

No. XIII in Centre County.†.

Most of the Allegheny Mountain plateau in Centre Co. has been denuded of its former covering of coal measures; but considerable areas of them are preserved along the centre line of the *First Basin*, swinging northward along Moshannon creek and the West branch of the Susquehanna river, over the First-or Pine Glen-Hyner axis into the *Second Basin*. Along the south-western edge of the county there is a continuous belt 16 miles long and from 2 to 3 miles wide along the Moshannon in Rush twp; another area 9 miles long and 3 miles wide around Snow Shoe, Moshannon, Pine Glen and Germania, forming the region of greatest development and stretching west to the Susquehanna river; and a number of smaller patches along the head-waters of Beech creek and on Hays run, along the Burnside-Snow Shoe twp. line and in Curtin twp., forming detached areas of only the lowest beds of the Lower Productive coal series.

The *Freeport upper coal*, 5′ thick, caps the highest knobs in 15 different patches in the county, sparingly covered with blocks of the Mahoning sandstone and now very largely exhausted.

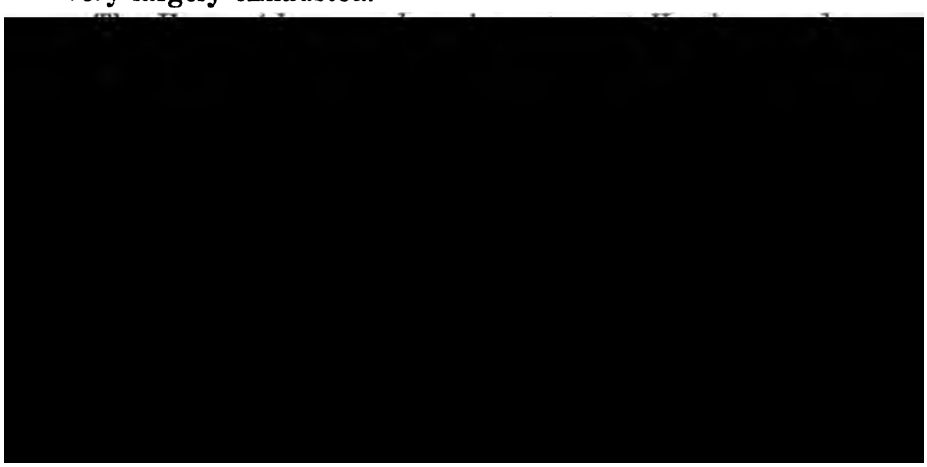


PLATE 407.

No XIII Allegheny Coal Series in Centre County Pa.

Vertical Sections in First & Second Basins.



The *Kittanning upper coal,* * is the bed of the region, from 5′ to 7′ thick, in three benches with a coarse cannel roof. Numerous small downthrow faults are met in the mines around Snow Shoe, and one of considerble effect and extent passing east and west through Snow Shoe twp. has seriously affected the mining.

Four lower beds exist, three of them with mining thickness of from 3′ to 4′, but only one, the *Lower Kittanning bed* B, has furnished any large quantity of commercial coal; and this latter bed is almost everywhere inferior to the Upper Kittanning C′.

The Freeport lower limestone, closely underlying the thin lower Freeport coal, is the "key-rock" of the district, from which all measurements are made and the coal beds identified.

The synclinal axis of the First basin passes north of the Hog Back in Curtin twp.; thence along Beech creek to Gray's splash dam and thence a little south and west through Sugar Camp hill, Holt's and Askey's hills to the Moshannon, crossing which it extends north of Peale in an approximate line with the *Morrisdale-Philipsburg-Osceola trough* of Clearfield Co., (see report H 6).

This trough rises and falls on the line of its strike, alternately lifting into the air and burying its coal beds.

Only the *Lower Productive Coal Measures,*† 280′ to 300′ thick, have escaped erosion, there being merely remnants of the *Mahoning sandstone* member of the overlying *Barren Measures* left on the highest hills. In the interval of 63′ between bed A and B there frequently occurs a small and worthless bed A′ from 1′ 6″ to 2′ thick, usually from 15′ to 25′ above A to which the name of Clarion is given. To the triple Kittanning group has been assigned the let-

* Locally known as "Bed D" from early errors in supposing the Free port group to be triple.

† As the revised surveys of Centre and Clearfield Cos. have rendered certain changes necessary in the nomenclature of the coal beds of this series to make them agree with other districts of the state, reference is made to a section of this group in report H page 69, to which the more recently adopted names of the several coal beds are given in brackets in Plate 407 Figure 1.

ters B, C and C′—*Lower*, *Middle* and *Upper*, with an intermediate bed between beds C and C′, usually showing 2′ of lustrous peacock coal, with a hard slate roof and very persistent in this region, named the "*Gorman*" coal by W. G. Platt (report H 4).

The error of originally making the Freeport group *triple* and introducing a middle member arose from a variety of causes,* among which may be mentioned the following:—

First: The frequent absence of distinct limestone benches in this field which characterize the horizon of these coal beds furthur west. *Second*: From mistaking the Johnstown cement bed *under* the Kittanning upper coal for the limestone *under* the Freeport lower coal. *Third*: The thinning of the great *Moshannon-Morrisdale-Karthaus* (Lower Freeport) *bed* "*D*" from 4′ to 6′ thick in those regions to about 2′ at Snow Shoe, and the consequent false identification of the large bed along the upper Moshannon creek as the large ("Middle") bed at Snow Shoe, whereas in reality they are two distinct beds, D and C′.

Snow Shoe Coal Basin.

The developments in this basin proper have been almost entirely confined to the Kittanning lower (B) and upper (C′) and the Freeport upper coal, (E). Some of openings formed the oldest bituminous mines in the state. The Freeport upper limestone was nowhere noticed in this dis-

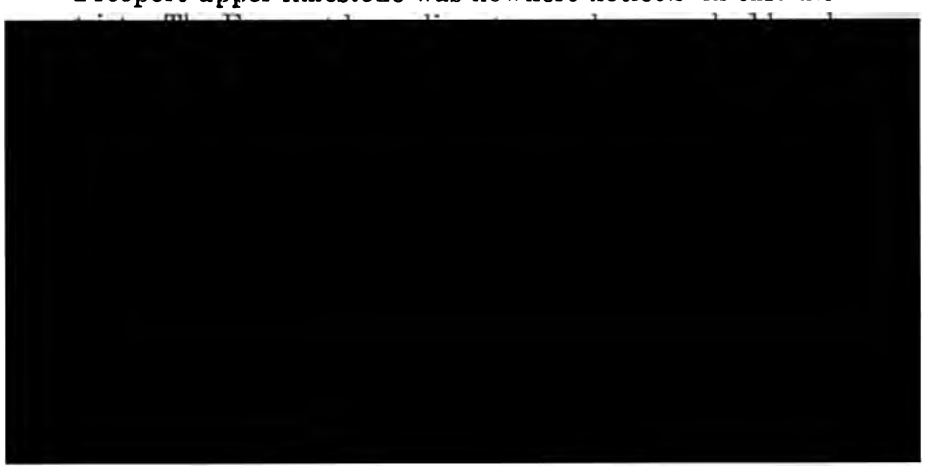
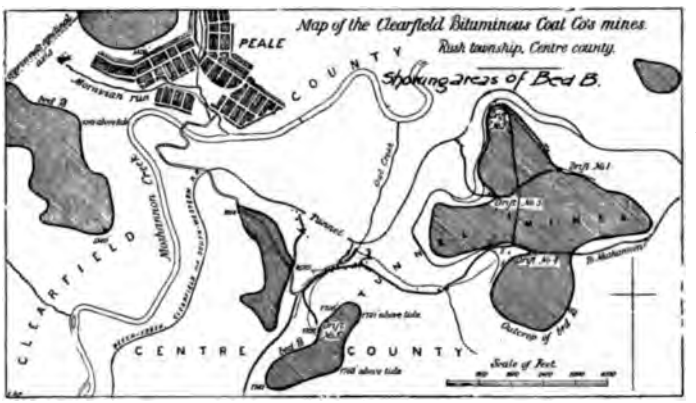


PLATE 408

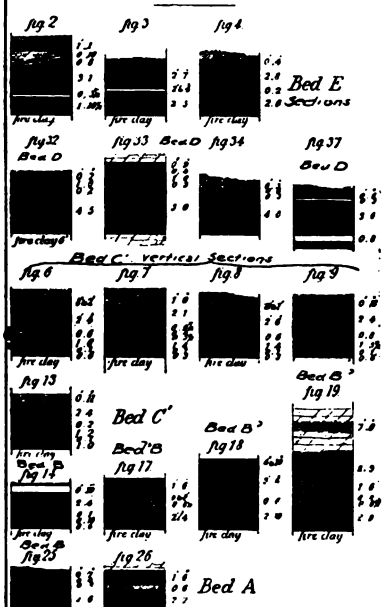
No XIII Allegheny Coal Series in Centre County Pa.

Report T. H. E. V. d'Invilliers.

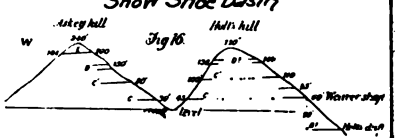


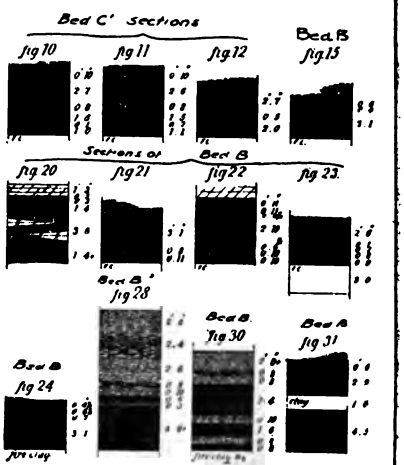
Detailed Sections of Centre County Coal Beds

Sections in Centre county.



Sections in Centre county.
Snow Shoe Basin







tate and another on the Byrd Coal & Iron Co. tract on the north side of the basin in Burnside twp. Where opened it shows an extremely handsome 5′ bed of bright clean coal, mainly of columnar structure, with a 2″ to 3″ slate parting dividing the bed in half. It is above the average of marketable coals and has made an excellent coke. All the openings on this bed in Snow Shoe have proved it to be seriously troubled with rolls and small faults, though it has been largely mined.

The *Freeport lower coal* bed D* is nowhere worked in this basin and its general character of a thin and worthless bed about 2′ thick, warrants its neglect. Two small patches of it occupy the tops of the double curved Sugar Camp hills; but to the eastward it is not caught again through the Beech Creek region. It crowns the hill north of William Holt's house where it is reported 3′ thick and is again caught in the high ground on the Blanchard and Waddle and the Byrd C. & I. Co. tracts. Similar small areas occur on the Stewart lands between branches of Seven Mile run east of the pike, but generally undeveloped.

The *Kittanning upper† bed C*—the "middle" or "big bed" of Snow Shoe—is by far the most important seam in this basin. Lying everywhere above water level

*Together with its underlying limestone it may be traced around Lucas and Coal hills and its position is indicated by the darkest tint on the colored geological map accompanying report T 4.

†The bed often carries from 10″ to 1′ of bone coal on top and its upper and lower partings will average about 6″ and 2″ thick. These measurements are often locally varied by reason of proximity to rolls or actual faults; but the bed can be relied upon to furnish from 4½′ to 5′ of good merchantable coal. It yields about 70% of fixed carbon, 25% volatile matter, 1% sulphur and from 3½% to 7% ash. In Sugar Camp hill frequently but two benches, capped with 6″ of bone coal; an upper 2′ 7″ and a lower 2′ thick, separated by about 5″ of bony coal and slate. In Sugar Camp drift No. 2 the coal benches are 2′ and 1′ 5″ and parting only 1″ of slate; but in same mine the bed again takes on its triple character with benches of 2′ 4″, 1′ 2″ and 1′ 0″, with thin slate partings of 1″ to 2″, and carrying on top its bone coal 11″.

It is therefore manifest that the identification of beds in the Snow Shoe basin (as indeed elsewhere) is not possible on the testimony alone of partings or benches, and with the Freeport lower limestone in place on top of Sugar Camp hill as a *key rock*, it is altogether probable that the main coal in this part of the basin is the Kittanning middle bed C locally enlarged; otherwise the interval of intervening rocks has been doubled.

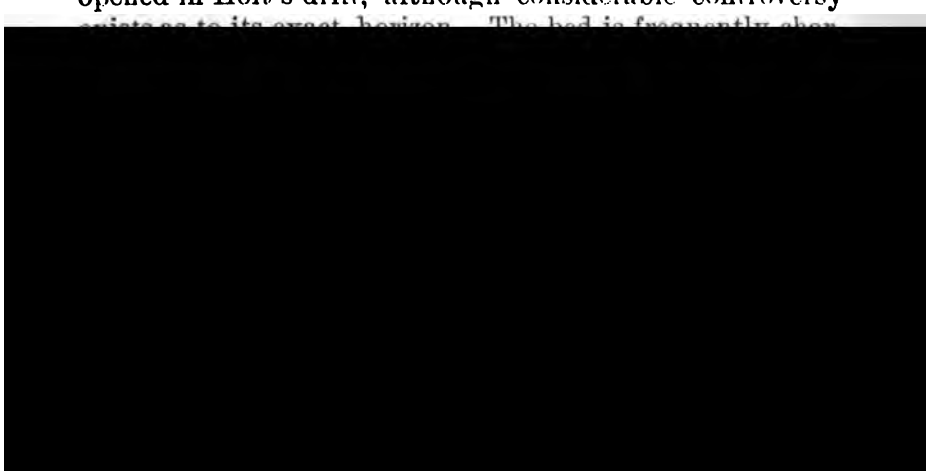
and retained over considerable areas where it is always a merchantable coal, its great thickness in the Snow Shoe trough readily accounts for its having been mistaken for the Freeport lower bed of the Moshannon region. A large amount of coal has been taken from it between the forks of Beech creek; in Harned, Jacobs & Co. drift on Coal hill and elsewhere.

Its general character is that of a rich bright heavy coal, capable of making an excellent coke with proper care in preparation. Its average section shows a triple bed, an upper bench 2′ 4″ to 2′ 7″ thick; a middle bench 1′ 2″ to 1′ 6″ and a lower bench from 5″ to 1′ thick.

The *Kittanning middle bed C* is generally slaty and 4′ thick. The *Kittanning lower bed B* has been considerably worked in Centre Co. during recent years, and more so since the gradual exhaustion of the better and higher Kittanning upper bed C′.

It has been mined in Coal hill between the forks of Beech creek and to a considerable extent in the north side of the basin.

In Askey hill it shows an upper bench 6″ and a lower bench 3′ 1″ thick, the slate parting between the two benches 4″ thick. The coal is lustrous and remarkably free from impurities, and seems to have lost a considerable portion of its upper bench. It is probably this bed which has been opened in Holt's drift, although considerable controversy



The *Brookville coal bed A*, being largely under water level in this Snow Shoe basin, has not hitherto received much attention; but as far as known it will not average over 3′, and is impure. This bed has also a small area to the east of Moshannon village, separated from the main Snow Shoe area by Little Moshannon creek. It was opened on Bieghtols run, reported 3′ thick and again at P. Walker's on north side of run, 4′ thick.

The *Clearfield Bituminous Coal Co's. mines*† (see plate 408) is the only other merchantable area in the western part of the basin, where about 300 acres of the *Kittanniug lower coal*, with neighboring small remnants, have been caught on the high ground between the waters of Big and Little Moshannon creeks, at the tunnel of the Beech Creek R. R.

First Basin along Beech Creek.

This basin is but an extension of the Snow Shoe trough just described, and though a number of test pits have been made, the mining developments are very meagre. The continuity of the measures is everywhere interrupted by the numerous streams entering Beech creek from the north and south, confining the coal deposits to the hills between them. Repeated examinations in this field seem to indicate, *First:* That nowhere east of Sugar Camp hill at Snow Shoe do the Freeport coals exist along Beech creek, and *Second:* That it is extremely doubtful whether the Upper

The fault developed in the Snow Shoe mine No. 8 on the south side of Beech creek, with a bearing N. 8° E. and S. 8° W. would certainly pass somewhere between the Hoy and Holt drifts if continued northwards, and apparently the coal beds on the west side of this line are generally reduced in size as compared with those on the east side. Almost similar circumstances occur in the Trullinger lands on Little Sandy creek still further northeast.

†In November, 1883, the company had located five drifts on this land, four in the main body of 300 acres and one in the 50 acre patch on the hill south of the tunnel. In places the bed shows its usual character, two benches 3′ 1″ to 4′ 3″ thick, sometimes with streaks of sulphur and a lower bench 11″ thick, the two separated by about 8″ of slate.

In No. 3 drift there are no less than four benches, 11″, 2′ 10″, 0′ 6″ and 0′ 10″, although the two upper partings are mainly bone and sulphur 0½″ thick, the main parting between the two lower benches being slate about 10″ thick. In drift No. 5 on the 50 acre patch there is an upper bench of dull coal 2′ 6″ thick; a middle slaty coal 7″ and a soft bottom coal 9″, with bone and slate partings of 1″ and 8″.

Kittanning bed C′ is retained in the hills in this part of the basin beyond the latitude of Wolf creek and certainly not to any commercial extent beyond Cato. The next lower bed C, the Middle Kittanning or "slate vein," is in no better condition here than it is at Snow Shoe, so that any commercial value that is to be attached to properties in the Beech Creek basin must be derived from the presence of the two lower coals, A and B, and limited areas of C′.*

Philipsburg-Osceola District, First Basin in Centre Co.

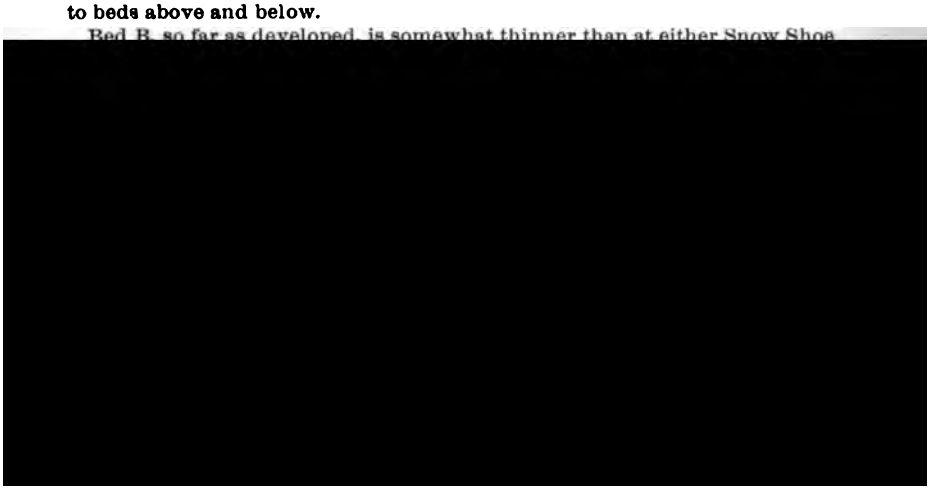
This western extension of the Snow Shoe trough is only coal-bearing in Centre Co. between Black Bear run and the western end of the county along the Blair-Cambria Co. line. The lowest coal beds of the Lower Productive measures have their southwest outcrops just west of Sandy ridge on the T. & C. R. R. and are seen along the railroad to Osceola.

The *Kittanning lower bed B* has been extensively mined at Powelton where it lies 45′ over bed A as against 63′ at Snow Shoe. It here carries 8″ of bony coal on top of an equal thickness of black slate, beneath which there are

* See plate 408. Bed C′ occurs in Bingham tract on Trullinger lands where it is reported to show a section similar to Sugar Camp. The same bed caps highest hills at Cato but is probably entirely absent to the east.

Coal C has been found in many test pits; but from its almost universal slaty character it is of no commercial value and is mainly useful as a guide to beds above and below.

Bed B, so far as developed, is somewhat thinner than at either Snow Shoe



three benches of coal, 3′ 4″, 1′ 6″ and 0′ 8″ thick, with slate partings of 10″ and 8″. The coal in the main bench is lustrous with columnar structure, somewhat sulphurous, the sulphur occurring in bunches rather than seams through the bed. Analyses of the upper and lower benches showed respectively sulphur 1.079% and 2.691% and ash 4.270% and 5.400%, both benches showing about 22½% of volatile matter and from 68½ to 71½% of fixed carbon.* Bed C, 3′ thick, occurs 35′ higher, separated by 30′ of shales from a small 2′ bed above which in turn is capped by 40′ of shales to hill top.

Southwest of Osceola bed B seems to be much more sulphurous and very little attention seems to have been paid to it there in the presence of the openings on the Lower Freeport coal.

The *Lower Freeport bed D*, so important and largely mined in this basin in Clearfield Co., only exists in four small and narrow strips on the east side of Moshannon creek, owing to the rapid rise of the measures to the southeast towards the Allegheny mountains. Around Philipsburg the country is generally broad and flat and none of the hills on the Centre Co. side are high enough to contain the Freeport measures. The basin, rising from Philipsburg to the northeast and to the southwest, has likewise contributed to the effects of erosion in the higher members.

The *Osceola mine* and *Sterling No. 3 mine* both work this Lower Freeport or Moshannon bed D in Buck ridge facing the creek.

Only the main lower bench of coal, 4′ 5″ to 5′ 0″ thick is mined at these places. Above it there occurs a streak of cannel 2″—3″ thick; soft coal 1′ thick and on top, bone coal from

* The Phœnix mine on bed B on Moshannon creek near Osceola shows a top bench of impure bony coal 1′ 1″ thick and a bottom bench of clean columnar coal 3′ thick with a slate parting 0′ 7″ thick.

The old Ætna and Boynton collieries also operated this coal which shows at the latter mine two thin benches of 6″ and 1′ 8″, separated by bone, coal and slate 1′ 10″ thick. The measures pass through this hill and on to Cold Stream run, though the hill is low and probably only holds a small patch of the Kittanning upper C′. On this stream bed B again shows benches, 0′ 6′, 2′ 9″ and 4′6″ thick with a knife edge slate between the two upper benches and soft fire clay 1′ 6″ thick between the lower benches.

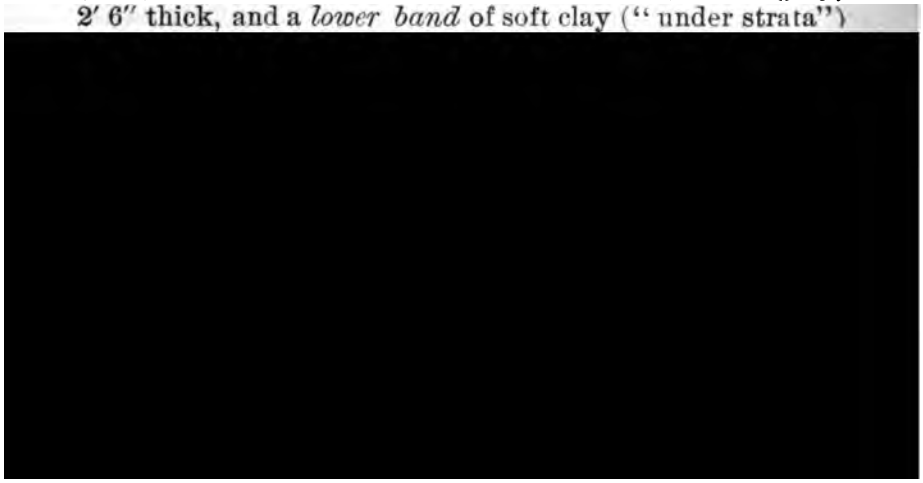
2″ to 4″ thick. A second opening on the Powell property about 600 yards south-west shows the main bench to be but 4′ thick, but still carrying above it 3″ of cannel coal, 6″ of soft coal, 3″ of bone coal. It may be said therefore that the Lower Freeport coal yields here from 4′ to 5′ of the same excellent steam coal which has made the fuel of this great bed in Clearfield, Jefferson and northern Cambria Co. so famous and well known in all the tide water markets.

The *Brookville coal* A is not mined along Moshannon creek, being generally too sulphurous and dirty for commercial purposes. It ranges from 4′ to 4½′ thick and probably shows its best development on Cold Stream run, although there as elsewhere, dirty.

At Sandy Ridge it is also 4′ and over in thickness, separated by an interval of 35′ to 40′, mostly sandstone, from the *Homewood sandstone* or top member of the Conglomerate Series.

Fire Clay Beds.

At Sandy Ridge and at Powelton in this county there occurs an important bed of fire clay which has been extensively wrought for many years. This clay occurs immediately on top of the Conglomerate and at Sandy Ridge shows three different members; an *upper bed* of soft clay (blue) 2′ thick; a *middle band* of hard clay (French gray) 2′ 6″ thick, and a *lower band* of soft clay ("under strata")



4″ thick, occurs about 9′ from top of clay in the overlying black slate roof. It is bony and sulphurous, though formerly mined here for local use at the works, and underlies bed A by at least 30′.

The two upper bands of soft and hard clay have been extensively mined from and they both vary considerably in thickness, the upper from 2½′ to 6′ and the lower from 2′ to 3′ 4″. The hard clay is crushed in its natural state with sand obtained from the sandstone floor; moulded, pressed and burned.

The *top* (blue) *clay* is well adapted for furnace bottoms; the *hard clay* for a No. 1 fire clay and the *under strata* is used for tiles and in-walls of furnaces not requiring as high a grade of brick. The essential difference between the clays is in the precentage of iron which is believed to occur mostly as a silicate of the protoxide. The blue clay contains most iron; the under strata less, though more than the hard clay. In addition to the iron, producing black specks in the burned brick, the alkalies are also detrimental.

At *Powelton* *, ¾ths. miles north-east of the Sandy Ridge mine, the same bed is worked 72′ lower along the south flank of hill. A bony coal 4″ to 6″ thick occurs here immediately on top of the soft clay, 2′ 3″ thick, underneath which is hard clay 11″ thick. The deposit is subject to squeezes as at Sandy Ridge which are apt to occur in any part of the mine and mostly affect the upper soft clay.'

Coal Measures of the Second Basin along the Susquehanna.

A general vertical section of *Buttermilk hill* on the east side of the river† opposite Salt Lick is given in plate 407.

*There is a comparatively small precentage of iron in the clay at Powelton as will be noted by reference to another suite of analyses given in T 4 page 120. Otherwise the various ingredients are quite similar to those at Sandy Ridge.

†Owing to the lack of railroad facilities on the east side of the river no mining developments have been made on the Center Co. side; but there is a considerable area of the measures here, extending northward from the Moshannon creek to Spruce run. The area between Spruce and Pine runs possibly takes in some of the Kittanning bed B, and the country between Pine and Miles run the Kittanning middle C, with possibly a small patch of the Kittanning upper C′ close to the Pine Glen-Buttermilk Falls road.

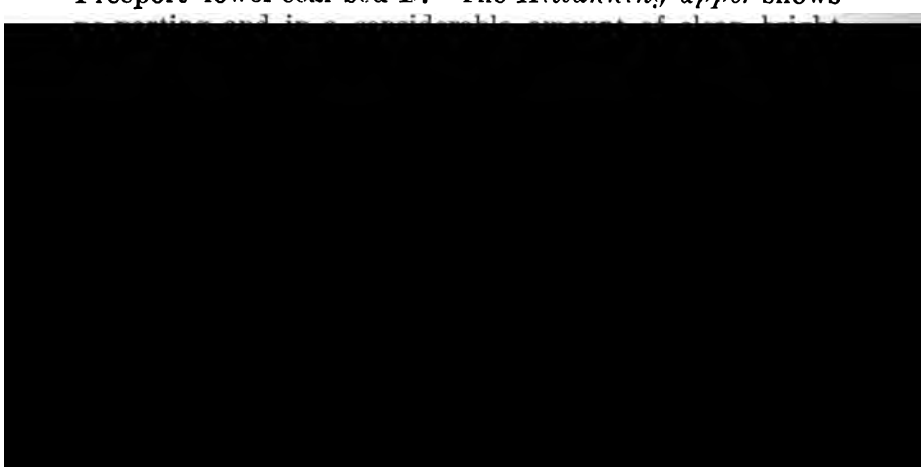
From this section it will be seen that this is the only point in Center Co. where the entire *Lower Productive group*, 234′ thick, is exposed together with the *Conglomerate Series*, 225′.

On the Buttermilk property a number of test pits have proven the presence of all the coal beds given in the section.

The *Freeport upper coal* is reported to be 3′ 6″ thick and I measured that thickness with 4″ of slate near the bottom in a trial drift north of Cap. White's house. The same coal has been found in a shaft ¼ths. miles northeast, near the Dickson house, where the bed is 4′ thick and in another small shaft nearby 4′ of carbonate ore was found 20′ beneath the coal, marking the horizon of the Freeport upper limestone.

The *Freeport lower coal* bench* can be distinctlyfollowed at an interval 30′ lower; but very little attention has been paid to it owing to its thin condition in the Snow Shoe region. The vertical section at *Sterling* is given in plate 407.

The *Kittanning upper C′*, bed No. 3 of Buttermilk section, has been drifted upon 92′ below bed E and showed a face of clean coal 2′ 8″ thick with a firm slate cover. It will be seen to what extent this bed has deteriorated as compared with its section at Snow Shoe; but this is compensated for in a great measure by the enlargement of the Freeport lower coal bed D. The *Kittanning upper* shows



The *Clarion bed A*, No. 6 of the section, is here as elsewhere worthless as a mining bed, being only 1′ 6″ thick and separated from the Kittanning lower by 32′ of shale and slate.

The *Brookville coal A*, 22′ lower in the section, shows 2½′ of good coal at its outcrop, slightly sulphurous, but not nearly as much so as in the First basin. It shows a similar section in a drift along the public road up from Sterling landing, about 320′ above the river, underlaid by 40′ of shale and fine grained blue (Homewood) sandstone, 20′ of shaly sandstone and then conglomerate to the river. The coal is lustrous and free from impurities. None of these beds had been sufficiently tested at the time of the Survey for them to indicate their eventual character when opened for mining. The features of this basin show the same absence of limestone as already remarked in the First basin, though at Karthaus in Clearfield Co. several horizons can be identified. The limited amount of the Freeport group still left on the east side of the river will be remarked by referring to the geological map; but its proximity to a ready market should lead to a more thorough testing and development of this region.

*No. XIII in Clearfield County.**

Structurally the most pronounced features of the county are the presence of two great anticlinal waves—the *First* or *Laurel Hill axis* ranging along the eastern side; and the *Second*, *Driftwood* or *Chestnut Ridge axis* through the western half.†

*This county was originally reported upon by Mr. Platt in 1875 in a hurried preliminary reconnaissance of the several bituminous counties lying immediately west of the Allegheny plateau and a revised report upon Clearfield Co. by Dr. H. M. Chance in 1883. The exceedingly rapid development which has attended coal mining in this county during the last 20 years, since the inception of the Second Geological Survey, would render it almost incumbent to prepare a third report by this date, in order to insure the proper presentation of details concerning later developments.

†In addition to these axes, which separate the *First*, *Second* and *Third Bituminous basins*, Dr. Chance has shown the presence of a third subordinate axis, called the *Nolo-Marion anticlinal*, which subdivides the Second Basin between the Cambria Co. line and the Susquehanna river; the

The whole tendency of the structural features of the county is to preserve larger areas of the Lower Productive coal measures in the several basins towards the south-west, the whole rock series rising north-eastwardly and exposing successively lower and lower beds. The quantity of coal preserved to Clearfield Co., in the two Freeport coal beds, lying here from only 25′ to 40′ apart, and in the Kittanning group occupying a space of only 70′ or 80′, is immensely large; but the Clarion series is not productive. The two principal beds are unquestionably the *Lower Freeport* or "*Moshannon*" *bed D* (especially in the First basin) and the *Lower Kittanning bed B*, with a characteristic fire clay parting.‡

The limestones of the Lower Productive Measures are also frequently found, though they cannot be considered persistent.§

In some particulars the typical general section of the *Lower Productive Coal Measures* given in plate 409 differs from that of Jefferson and other counties lying in the western basin. The Freeport upper coal E lies generally closer to the Freeport lower coal D, this interval ranging from 25′ to 40′.

The *Freeport lower coal D* is separated from the Kittanning upper by an interval of from 45′ to 50′, while along

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Third or *Boone Mt. anticlinal* just touches the north-western edge of the county, bordering on Elk and Jefferson Cos., and serves to limit the west-

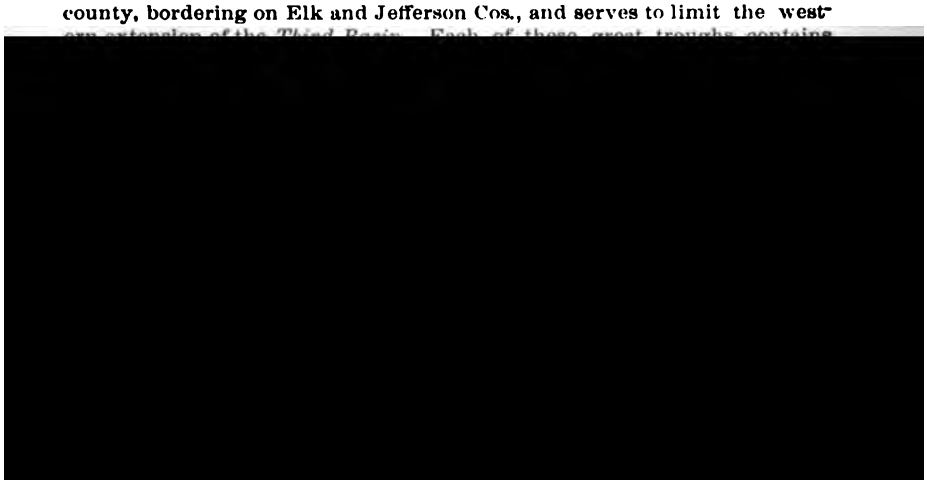
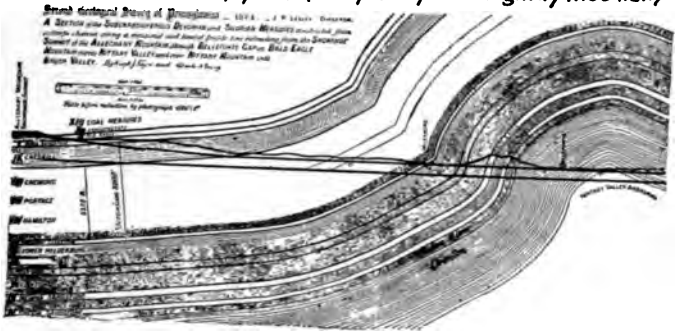


PLATE 409.

No XII Allegheny River Series in Clearfield County, Pa

Cross-Section from Nittany Valley to Allegheny Mountain



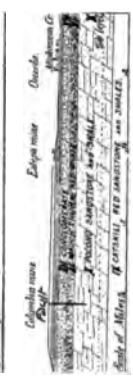
Clearfield County

General Section, Fig. 1.

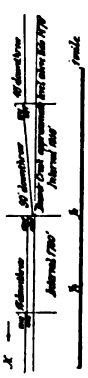
	Observed limits.	Average.
Mahoning sandstone—the top rock.		
Shales and slates, sometimes ferruginous,	20' to 40'	30
Freeport Upper Coal—E,	2' to 4'	3
Fireclay, 2' to 6'		
Shales with ore,	25' to 40	30'
Freeport Upper Limestone,		
Shales and slates, sometimes sandstone,		
Freeport Lower Coal—D,	2' to 7	3½
Fireclay, 1' 6" to 4'		
Freeport Lower Limestone, 2' to 4'	42' to 58	47'
Shale—place of Freeport Sandstone,		
Kittanning Upper Coal—C',	1' 6" to 5'	3'
Fireclay, 2' to 6'		
Johnstown Cement bed, 2' to 4'		
Shales and slate, (thin,)	20' to 40	25'
Coal—Unnamed, 0' to 2'		
Fireclay, 0' to 2'		
Shales and slate,		
Kittanning Middle Coal—C,	1' 6" to 5'	2'
Fireclay,		
Shales and slates,	25' to 40	25
Sandstone, fine grained, tough,		
Kittanning Lower Coal—B,	2' to 7'	4'
Fireclay, 4' to 5'		
Shales, sandy, 20'	Sometimes occupied by Clarion Sandstone	
Clarion Coal—A', 1' to 2'	70' to 80'	
Fireclay, 2' to 10'		
Shales, 20' to 30'		
Brookville Coal—A,	0' to 4'	2'
Fire-clay—brick-clay,	0' to 10'	5
Pottsville Conglomerate, No. XII.		

Map of Clearfield Cathy Coal Measure Outcrops





Downthrows east of Houtzdale.





the Allegheny river this interval is often much larger. It there carries the Freeport sandstone, sometimes measuring 60′ to 70′; in Clearfield Co. this rock is always thin and sometimes all shale and slate.

The *Kittanning upper coal C′* is here found at about the same intervals from the Kittanning middle C and the Kittanning lower B coals as in the western part of the State; but the Kittanning group in Clearfield, Centre, Cambria, Indiana and Jefferson Cos. contains an additional bed of coal, about midway between the two upper Kittanning beds, rarely more than 2′ thick, now pretty well known under the name of the "*Gorman*" coal. Finally the absence of the *Ferriferous limestone* as a persistent stratum in this district apparently effects a reduction of interval between the Kittanning lower coal and the Conglomerate. In some localities the whole interval from bed B down to bed A is occupied by the Clarion sandstone, where the Clarion coal bed A′ is cut out by the sand rock. This Clarion sandstone, in such cases, singularly resembles the Homewood sandstone. It is often massive and conglomeratic, sometimes carrying pebbles as large as a pea or larger; but more commonly it is a rather friable yellow sandstone, weathering down to a reddish or yellowish sandy soil, made more or less clayey by the heavy bed of fire clay that frequently underlies bed B, resting directly upon this rock.

The average interval between bed D and bed B, base to base, is 128′. In the Houtzdale—Morrisdale region it ranges from 120′ to 125′, as against 160′ on the Allegheny river and 140′ in the Second basin along the Susquehanna and in the Low Grade field.

The *Freeport upper coal bed E* ranges from 3′ 6″—3′ 8″ in the Morrisdale—Phillipsburg region to 2½′ or 3′ near Houtzdale. It is commonly 2½′ to 3′ thick in the Second basin, possibly approaching 4′ in Karthaus twp. In the high ridge south of Clearfield and Curwensville it sometimes reaches and locally exceeds 3′. In the Houtzdale—Morrisdale district it shows a coal of excellent quality; but it has been ruined by the workings on the Lower Freeport

coal, 30′ beneath it. It cannot be considered of much importance in Clearfield Co.

The *Freeport lower coal D* is the celebrated "Moshannon vein."* It nearly always yields a coal of good quality and has a good workable thickness in parts of 12 townships; but the total area of this bed (outside of the First basin) that has been proven to contain this coal with good workable thickness, is quite small, probably a few thousand acres.

The *Kittanning upper coal bed C′* is generally quite thin and unimportant in the First basin; but on the Clearfield creek slope of this basin the bed has been found in much better condition; from 3′ to 5′ thick, often containing one or several slate partings. In the Curwensville, Bloomington and Ansonville district this coal reaches a thickness of 3′ to 3½′ and furnishes a coal of excellent quality. It is here the most important bed in the series and is probably of good workable thickness in parts of the Pennville district. In Girard twp. and eastern Goshen it is in places 4′ thick and has attained a thickness of 3½′ in Karthaus twp. At Westover in Chest twp. it shows over 4′ of clean coal, and the rapid exhaustion of the overlying Moshannon seam in this county will assuredly lead to more careful explorations of this bed to determine points for mining it.

The *Kittanning middle coal bed C* is commonly too thin for present working. Ordinarily about 2′ thick, it is sometimes badly parted by sandstone. In Girard, Bradford and

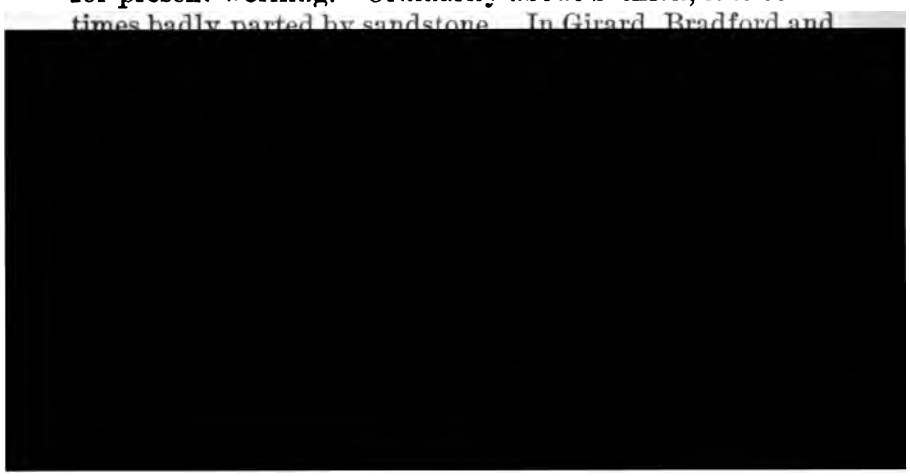
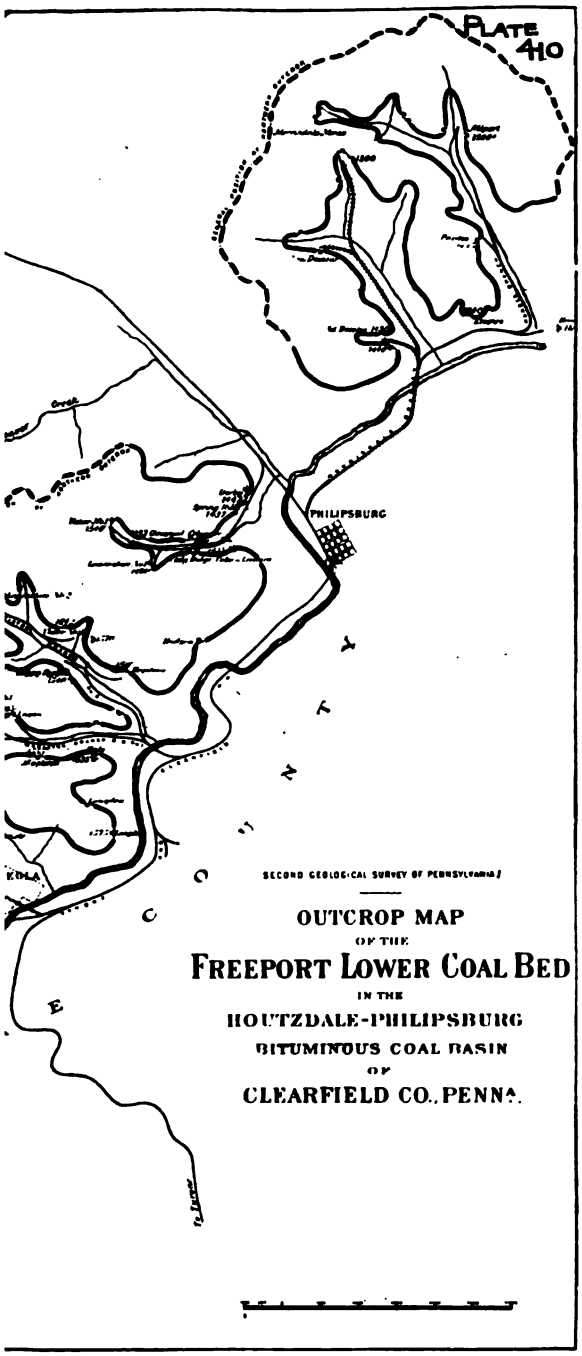


PLATE 410.




PLATE 410
PHILIPSBURG
SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA
OUTCROP MAP
OF THE
FREEPORT LOWER COAL BED
IN THE
HOUTZDALE-PHILIPSBURG
BITUMINOUS COAL BASIN
OF
CLEARFIELD CO., PENNA.



second bed of fire clay rests, supporting an upper bench of coal; and frequently this upper bench is again divided by a slate parting. The middle bench is commonly thicker than either of the other two; the bottom bench is often extremely sulphurous and therefore frequently not exposed in the mines at all, and the top bench is sometimes only a few inches thick. At some openings the coal shows apparently as a bright clean bed, with no sulphur visible; but an analysis nearly always discloses the presence of over 2% of sulphur, and the coal rarely yields less than 9 or 10% of ash. When dirty, both the sulphur and ash will exceed these percentages.

The *Brookville coal bed* A is perhaps the most unreliable bed of the series, ranging always from a few inches up to 4′ in thickness and at times entirely absent. When thick it is usually slaty or sulphurous, and when good it is generally quite thin.

Immediately beneath this bed occurs the fire clay deposit that has been so extensively used in the manufacture of fire brick along the line of the Tyrone and Clearfield R. R.

*The Houtzdale-Philipsburg Basin.**

The map of this basin, showing the outcrop of the *Freeport lower coal*, will be found reduced on plate 410. The basin is full of faults, a new and somewhat unique feature of Pennsylvania bituminous coal geology, first clearly shown by Dr. Chance, and naturally of the greatest economical inportance.† Troublesome as they are when met with in mining, it is to their presence in the First Basin which has led to the preservation and repetition of such large areas of the Moshannon coal, which has made that district famous.

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*A general section in the Houtzdale-Morrisdale basin is given in plate 412 of this report.

†Three of these faults at the Moshannon workings are shown on the map. Serious faults have also been encountered in the Morrisdale mines—an upthrow of 42′—in the Allport, Franklin, Penn, Arctic and many other collieries; in fact there very few mines in this basin in which more or less serious disturbance has not been found, though none greater than at the Moshannon, 90′.

The *Mahoning sandstone* is a conglomerate along the Amesville ridge as far north-east as the head of Coal run; but coming east toward the center of the basin it looses its pebbly character and commonly occurs as a fine or rather coarse grained whitish sandstone. It is sometimes shaly or friable; and in many localities is either replaced by soft sandy shales or is entirely absent, its place being occupied by the Barren Measures shales and slates. The *Freeport upper coal E* has been worked at only a few banks. Ordinarily it contains not more than 6″ of coal, in places reaching 3′ in thickness. Its analysis from a selected sample by Mr. Platt shows F. C. 68.400; V. M. 24.630; S. 1.900 and ash 4.500. The coal is commonly clean and bright, with only a small percentage of sulphur. Workings will doubtlessly be opened on this bed in the future; but it cannot be considered a very valuable deposit in this basin: first, because it is not thick; second, because it lies too close to the hill tops to afford a very large workable area; and third, because it has been ruined over large areas by workings on the underlying bed. It is also very variable.

The *Freeport lower coal bed D** or "Moshannon seam" has been the mainstay of all the mining districts in Clearfield Co. It commonly yield, from 4′ to 5′ of coal, but varies locally from 3′ to 7′ in thickness. In the north-eastern part of the basin it usually contains a parting of slate from 1″ to 2″ thick, from 6″ to 15″ above the floor of the coal.

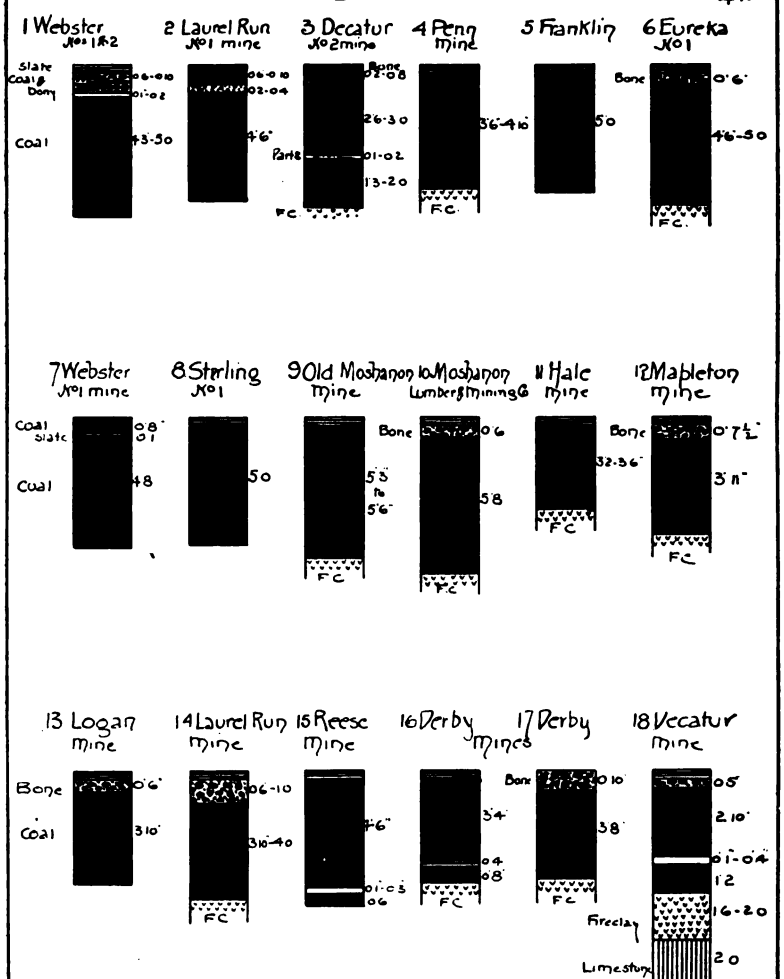


PLATE 411.

No XIII. Allegheny Coal Series in Clearfield County

Showing variations of the Lower Freeport ("Moshannon") Bed D in the Houtzdale-Philipsburg-Morrisdale (First) Basin

Rep H7



Fr d'l



In the vicinity of Houtzdale and north-east toward the Mapleton branch, the bed is all clean coal, without any slate parting, but often carries a layer of bony coal on top of the bed, from 4″ to 8″ thick. (See sections plate 411.)

The *Kittanning upper coal C*, commonly found from 40′ to 50′ below the Moshannon bed, is generally worthless in this basin. At the Morrisdale shaft it is 2′ 10″ thick, with a large slate parting in the middle. On the Kephard place, two miles north-west of Osceola, it contains 2′ 2″ of coal, with a very hard clay-slate parting in the center about 2″ thick. It shows the same structure near Amesville, with somewhat thicker parting.

The *Kittanning middle coal C* is almost entirely worthless in this basin. It lies 30′ to 35′ below bed C′ and 30′ to 40′ above bed B. Near Osceola it is reported 2′ 6″ thick

The excellent character of this coal, especially for metallurgical use, is shown by the following tables taken from the same source.

Analyses of Ash of Coal from Bed D.

No.	Silica.	Oxide of Iron.	Alumina.	Lime.	Magnesia.	Phosphoric Acid.	Sulphur.	Per cent of Ash in Coal.
1.	2.040	.350	1.140	.136	.032	.007		4.030
2.	1.600	.590	1.360	.134	.046	.013		3.800
3.	1.675	1.570	1.480	.221	.154	.013		5.120
4.	3.493	.750	2.700	.302	.168	.237		7.650
5.	2.100	3.550	1.550	.090	.206	Trace.		7.540
6.	1.450	.350	.500	.260	.198	.047	.054	3.100

Analyses of Coal D for Phosphoric Acid.

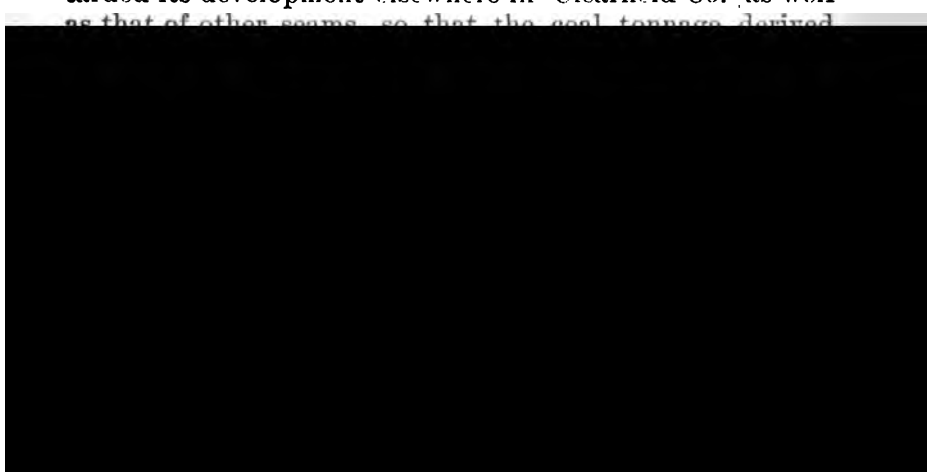
Name of Colliery.	Per cent. in Coal.	Per cent. in Ash.
Penn Colliery, Houtzdale,	.007	.174
Franklin Colliery, Houtzdale,	.005	.047
Eureka Mine, Houtzdale,	.013	.342
Sterling Mine, Houtzdale,	.005	.159
Moshannon Colliery,	.006	.162
New Moshannon Mine,	.005	.124
Mapleton Colliery,	.013	.253
Logan Colliery,	.237	3.098
Laurel Run Colliery,	.011	.366
Decatur Coal Co.'s Colliery,	Trace.	
Morrisdale Mine, Lower Bench,	.047	1.516
Morrisdale Mine, Upper Bench,	.022	.830
Derby Colliery,	.033	.397

with no slate partings, and while some workable areas will doubtless be developed in the future, the bed is usually a slaty, dirty coal, utterly unfit for use, and as a whole, must be considered valueless.

The *Kittanning lower coal bed B* does not furnish coal that compares well with that from bed D, and it is not therefore of much value at present, although isolated tests of recent date have proved its value at certain points. Below Osceola it contains a 6″ slate parting about 1′ below the top of the bed. At Philipsburg the parting is about the same thickness but comes in 2½′ from the top of the bed with an equal or greater thickness of coal beneath it. This is also its structure on the Pardee branch railroad.

The *Brookville coal A* is too rarely exposed and too inferior in quality in this basin to attract any attention at present. In other words, the enormous coal output of this *Houtzdale-Morrisdale basin*, which has been maintained for the past 20 years, has been derived almost entirely from the lower Freeport coal, bed D.* Its purity and excellence have made it a standard for all other coals of the Allegheny Mt. district and have led to its being mined with great rapidity to supply the constantly increasing demands for a first quality of bituminous coal.

The pre-eminence of bed section and chemical quality of the Moshannon seam in the First basin has naturally retarded its development elsewhere in Clearfield Co. as well as that of other seams, so that the coal tonnage derived



No XIII. Allegheny Coal Series in Clearfield County, Pa.

Vertical Sections in First & Second Basins.

General Section.

Houtzdale-Morrisdale Basin.

Mahoning Sandstone,	0' to 80'
North Slates and Shales, ferruginous,	35' to 40'
Freeport Upper Coal—Bed E,	2' to 3'
Fire-clay,	
Freeport Upper Limestone (seldom seen),	25' to 35'
Shales, (sometimes sandy,)	
Blue Slate,	
Freeport Lower Coal—Bed D,	4' to 6'
Fire-clay,	2' to 4'
Freeport Lower Limestone,	0' to 2'
Freeport Sandstone, (sometimes replaced by Blue Flaggle Slate),	25' to 45'
Kittanning Upper Coal—Bed C',	2' to 3'
Fire-clay, etc.,	3' to 8'
Johnstown Cement Bed (Limestone),	0' to 2'
Slates and Shales, (with a small coal),	25' to 30'
Kittanning Middle Coal—Bed C,	1' to 3'
Fire-clay,	
Shales and Slates,	20' to 60'
Kittanning Sandstone,	
Slate,	
Kittanning Lower Coal—Bed B,	2' to 6'
Interval to water-level of Monnahannon Creek below Osceola,	

2'0-3'0" Bed E.

40-60" Bed D.

2'0-3'0" Bed C'

10-8'0" Bed C

3'0-6'0" Bed B.

Along Chest Creek. (revised).

Hill top.	
Lower Barren measures,	50'
Mahoning Sandstone,	40'
Sandy Shales, etc.,	20'
Coal, Gallitzen,	3' to 4'
Fire-clay,	2'
Limestone, not opened,	3' to 4'
Sandstone	50'
Shales and Slates,	20'
Coal, Bed E, Freeport Upper	3'
Fire-clay,	2'
Limestone, not opened,	3'
Sandstone,	10'
Shales and Slates,	5'
Coal, Freeport Lower Bed D (D),	4½' to 6'
Fire-clay,	2'
Limestone,	3'
Shales and Slates,	20'
Coal, Bed C, not opened, thin,	1' 6"
Shales and Slates,	20'
Coal, Bed C, Kittanning Middle bed,	2' 6" to 3'
Fire-clay,	2'
Sandstone and Shales,	25'
Coal, Bed B, Kittanning Lower, (Coal with thin Slate, 4' 4" / Fire-clay, 1' 3" / Coal, 2' 8")	8' 3"
Fire-clay,	2'
Sandstone,	25'
Shales and Slates,	20'
Coal, Bed A', Clarion,	1' 6" to 2'
Fire-clay,	3
Sandstone, Sandy Shales, and Slates,	25'
Coal, Bed A, Brookville,	3 to 4'
Fire-clay and Sandstone,	12'
Fire-clay, Blue Ball, etc.,	6' to 8'
Homewood Sandstone,	40'
Coal, Mount Savage or Mercer,	1' 6"
Conglomerate (No. XII) to level of Chest Creek,	20'

5'0 Bed E.

4'6-6'0 Bed D

16" Bed C'

2-6" to 3'0" Bed C

8'3" Bed B.

16'-20' Bed A'

30-40 Bed A

Mount Savage or Mercer

Lumber City.

Soft shales,	
Mahoning sandstone, in hill-top,	100'
Soft shales,	
Coal Measures, Bed E.	
Shale and shaly sandstone, (Bed D not seen,)	60'
Coal seam, Bed C' (D.)	
Fire-clay, about	3'
Limestone, Johnstown Cement bed, about	2'
Shales, some sandy shale,	30'
Coal seam, Bed C (C.)	
Shales with 15' of flaggy, argillaceous sandstone,	80'
Coal seam, Bed B (C.)	
Soft shales,	45'
Coal seam, Bed A (B.)	
Soft shales,	80'
Coal bank, (saw fallen seam,) (A.) about	3½
Sandy and shaly measures to river level,	150'

Reuben Caldwell.

Coal (D?) in hill top, only a few feet of cover,	" say " 2'
Fire-clay,	" say " 2'
Limestone, (Freeport Lower?,)	" say " 2'
Interval, about	30'
Coal, (Bed C'?),	3 6"
Fire-clay,	20'
Interval, about	2'
Coal, (C?),	40'
Fire-clay,	2' 6"
Interval,	20'
Coal in well, (B?),	2'
Fire-clay,	12'
Interval,	
Fire-clay,	
Interval,	
Coal? Bench, springs, (Bed A?),	



only 2′ to 8′ thick. Better prospect of finding them of workable thickness east of Utahville, in the Muddy Run district, where they are deeply buried. It is a well known fact, proven now by extensive development, that in all the region tributary to Clearfield creek south of Ramey, the Moshannon seam bed D is split into two separate beds, separated by from 15′ to 25′ of rock interval around Ramey, which interval increases up to 50′ and 60′ along the lower portion of Big Muddy. The upper split seam is thin and worthless everywhere, while the lower split thins from 4′ on Bannion run and Clearfield creek to 3′ 6″ on Smoke run and from 2′ 6″ to 3′ 0″ along the Glen Hope–Janesville road, showing about the same character and thickness throughout the balance of its outcrop above water level on Big Muddy. Throughout the same field bed E is nowhere found workable, at best about 2′ 10″ thick. In Chest twp. the Freeport coals may approximate 4′ in thickness in some localities, but more frequently only 3′ in the region north and northeast from Westover. In Burnside twp. the Freeport lower is not supposed to exist in any very good condition around Cherry Tree, showing at the Westover mine the following section: Top coal 0′ 10″; slate 0′ 1½″; middle coal 2′ 3″; slate 0′ 2″; bottom coal 0′ 8″.

In Bradford twp., in the *Second Basin*, the Woodbridge bank is supposed to be opened on the Freeport lower bed D, 3′ 10″ to 4′ 0″ thick, of which the top 10″ or 12″ is bony and sulphurous. Bed E is everywhere thin. In Graham twp. both the Freeport beds are thin usually; but bed D varies from 3′ to 6′, and when over 3′ 6″ it usually carries a bad fire clay parting. In Pike twp. the two Freeport beds are thin, the upper 3′ and the lower 2′, separated by 42′ of shale (see section H, plate 413, compiled between Curwensville and Bloomington). Goshen twp. also shows a very small area and development of these coals. Bed E averages 3′ and bed D 5′ in the eastern part and 3 6″ in the western part; both beds rarely opened. The same statement pertains to Girard twp., the coals existing only to a limited extent in the highest hills; and they are generally absent in Covington twp. west of Ford's hotel. To the east of that place bed D shows 5′ of clean columnar coal.

In Karthaus twp., the Karthaus "Big bed" (which is doubtless the Freeport Lower or Moshannon coal bed D) extends over a comparatively small area. In places considerably over 6′ with only a small parting about 1′ from bottom and some bony coal on top, it will probably yield 5′ to 5½′ of merchantable coal. In other localities the bed shows 4′, 5′ and 6′ thick, but its average yield will not exceed 5′ of clean coal. Bed E is small at Karthaus, 2′ thick. The Karthaus basin extends north-east down the river several miles, the large bed D entering the hills above the neighborhood of Three Runs. On Birch Island run the Karthaus bed is 6′ thick and here bed E is said to show locally 4′ of coal. In Union twp., in the Third basin, some few openings have been made on the different coal beds, especially the Freeport group; but owing to the absence of railroad facilities and even local markets they have been largely abandoned. Coal smuts are frequently seen along the road between Rockton and Luthersburg, indicating the presence of beds lower than the Freeport lower coal bed D. Brady twp. is largely overspread by Barren Measures of Third basin whose axis line passes approximately near West Liberty; but coal D has been largely worked by shafts and drifts in the DuBois district as well as southward along Rochester and Pittsburgh R. R. East of Troutville this bed is worked at the Dunlap bank, measuring from 3′ 6′ to nearly 6′ 0″ of good clean coal, without persistent parting; the same bed is believed to have been opened

on north side of ridge at Faust bank, 4′ 9″ to 5 3″ with 1′ of bone coal on top. This is about the character of the great Jefferson Co. bed along the eastern flank of the Third basin. From West Liberty northward towards DuBois the measures lie rather flat and the Freeport coals do not come above water level until the latter place is reached, where the Lower Freeport coal D has been extensively worked by the Rochester and Hildrup Cos. (now Bell, Lewis & Yates) as well as by shaft south of DuBois by the Berwind-White Coal Mining Co. Around DuBois the bed has a good thickness, in some parts of the old Rochester mine approaching 7′ with a slate parting about 2′ below the roof. At the new Berwind Shaft colliery, bed D is mined 265′ beneath the surface, showing a main bench 5′ 6″ to 6′ 0″ thick; top bony coal 0′ 2″ and roof coal, not mined, 1′ thick. Other particulars concerning this Third Basin coal area will be found in Jefferson Co. notes.

Kittanning and Clarion Coal Groups.

The Lower Kittanning coal is referred to in many parts of report on Clearfield Co., though not largely developed. Thus 2 miles below Madera in Woodward twp., it is reported 5′ 6″ thick, near creek level. Ascending Clearfield creek it remains above water level from Porters run to and beyond Irvona. The Kittanning coals all have workable thickness in Becarria twp. The upper bed C′ in the vicinity of Glen Hope is about 3′ thick. The middle bed C near Coalport and around the mouth of Witmer run is from 3′ to 3′ 6″ thick, in prospect shafts and drifts. The lower bed B is opened and worked at a number of banks near Coalport where it lies about 100′ above water level. The Irvona Coal Co. have opened this bed with following section: upper bench 2′ 6″ to 2′ 10″; bone 0′ 3″ to 0′ 6″; middle bench 1′ 1″ to 1′ 3″; slate parting 0′ 1″; lower bench 1′ 4″ to 1′ 6″. In the Sykes and Jones, Elliott and Bryson and Richard banks the bed carries a larger amount of refuse and the bone is commonly from 6″ to 10″ thick, sometimes replaced by three or four thin slate bands lying close together. At Glen Hope the same coal has been opened 3′ 6″ thick. A number of old banks can be found here south-west of Clearfield creek, located on the Kittanning upper, in which the coal is claimed from 2½′ to 3′ thick. Opposite Glen Hope the Lower Kittanning bed is said to contain over 4′ of coal.

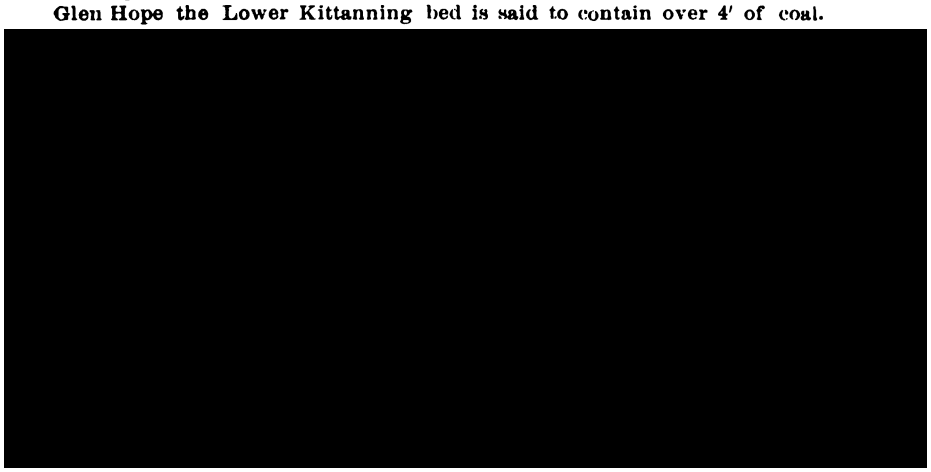


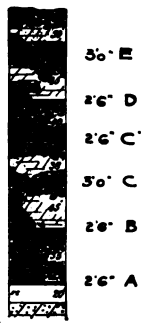
PLATE 413.

No XIII. Allegheny Coal Series in Clearfield County, Pa.

Vertical Sections in Second Basin.

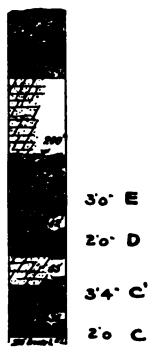
A. Section near Clearfield.

Slate, (in hilltops, sometimes above Mahoning SS.,)		20'
Coal, (Prospect Upper—Bed E,)		3
Sandstone and shale,		45'
Coal, (Prospect Lower—Bed D,)		2' 6"
Shale and slate, (with Prospect Lower limestone near top,		40'
Coal, (Kittanning Upper—Bed C',)		2' 6"
Interval, ("clay,")		7'
Limestone, (Johnstown Cement Bed,)		4'
Sandstone, (generally slaty shale and shaly SS.,)		30'
Coal, (Kittanning Middle—Bed C,)		2'
Sandstone and shale,		40'
Coal, (Kittanning Lower—Bed B,)		2' 6"
Shale and slate, (Charles S. S.,)		30'
Coal, (Brookville—Bed A,)		2' 6"
Fire-clay,		20'
Sandstone,	No. XII,	30'
Conglomerate,		100'



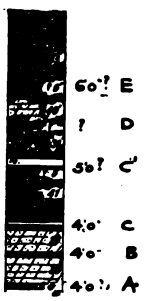
B. Section of Measures between Curwensville and Bloomington.

Barren measures,—slate, shale, and shaly sandstones, Mahoning sandstone, a thin shaly sandstone,	220'
Shale,	20'
Prospect Upper Coal, Bed E, (Smut) about,	3'
Slate,	40'
Prospect Lower Coal, Bed D, (reported,)	2'
Shale, with some little sandstone,	30'
Kittanning Upper Coal, Bed C',	2' 6"
Fire-clay,	2'
Johnstown Cement Bed, (Limestone,)	2'
Shale,	20'
Kittanning Middle Coal, Bed C, (reported,)	2
Interval to river level, about,	100'



C. Section (revised) at Madera.

Shales to hill top,	20'	Place of Mahoning S. S. in upper half of this interval.
Small bench and coal,	—	
Shales,	20'	
Bench reported once opened, 6' coal (Bed E.)		
Thin sandstone and slates,		40'
Bench not opened (Bed D),		6'
Shales, hard and impure, with a little iron hematite ore in small pieces,		35'
Fire-clay (reported),		9'
Black slate,		5'
Coal not opened, (C') called,		5'(?)
Shales and slates,		61'
Slates, hard and dark, covered with nodular carbonate iron ore,		9'
Black slate,		2'
Coal not opened, (C) called,		4'
Sandstone,		20'
Coal (B),		4'
Sandstone, (this interval nearer 60'),		20'
Coal reported at creek level (A),		4'(?)



Ekert.



both along the Moshannon creek and in the country south-east of Janesville on Little Muddy. It has been worked at the Davis bank and shows top coal 1′ 8″; bone 0′ 4″ to 0′ 8″; coal 3′ 4″; slate parting 1′ 0″—1′ 6″; bottom coal 1′ 0″. It carries sulphur .627 and ash 7.125%. The Kittanning Coal Co. report this to be about its average condition along the upper Moshannon, where they have made many test openings and trial pits. Morris twp. marks the north-eastern extremity of the Houtzdale—Philipsburg basin, terminating east of Morrisdale. Bed B north-east from Kylertown and at Beam's shows shaly slate roof; coal 0′ 7″; slate and bone 0′ 4″; coal, main bench 3′ 3″; fire clay shale 0′ 6″; coal, bottom bench 1′ 6″. Opened at several points along Moravian run; lower parting thickens approaching Moshannon creek, whilst the lower bench thins down to about 6″. In places the bed has been found 8′ thick with not more than 6″ of parting on Moravian run on property of Clearfield Bituminous Coal Co. The Brookville coal A has been opened on same property, 2½′ thick without parting and at few points 3′ and even upwards of 4′; 70′ below B. In Chest twp., in neighborhood of Somerville mill on Chest creek, the upper beds have not been opened; but on the east side of Chest creek near the Cambria Co. line the massive Mahoning sandstone, here a true conglomerate, has been found capping the hills. A vertical section of the measures, compiled partly in Clearfield and partly in Cambria Co. along Chest creek by Mr. I. A. Harvey is given in plate 412. In north end of township the beds are all of moderate thickness and while bed B may reach 5′ to 6′, it contains a troublesome slate, bone or fire clay parting and will not maintain that thickness on lower part of Chest creek. Bed C′ may reach 3′ in country adjacent to Jordan twp. and has been opened at Westover showing over 4′ of clean coal. Coal A is reported 3′ to 4′ but will probably average nearer 2½′ to 3′, usually troubled with sulphur and slate. In Burnside twp. the entire Lower Productive group may be found along various branch streams entering river between Cush P. O. and Cherry Tree. Bed B has been opened in the extreme north-western corner, near the Indiana Co. line, by Mr. James Brady, showing in all about 6′ with slate parting 1′ and a fire clay parting of equal thickness. The same section is exposed at the Dowler coal bank at the mouth of Cush creek. In Jordan twp. the Ansonville coal bank has furnished a large amount of excellent coal for local wants, and is judged to be the Upper Kittanning C bed, generally with two benches, 1′ 5″ and 1′ 10″ thick, separated by a thin slate parting, from 1″ to 2″. This bed C′ furnishes an excellent coal generally from 3′ to 3′ 6″ thick. Bed C is reported thin and Bed B, frequently reported 3′ 6″ to 4′, but averaging 3′ 6″ thick. In Ferguson twp. all the high ridges are capped with Mahoning sandstone; and though but few openings have been made in the underlying coal beds, an instructive and useful vertical section is given in plate 412, compiled from exposures in the hills going from Moore's place to Lumber City. The lowest coal is doubtless an inter-conglomerate bed, although it may represent bed A, with the Clarion sandstone represented by soft shaly members. The limestone in the section has been generally regarded as the Johnstown cement bed, under bed C′. The Kittanning upper bed may reach 4′ and the Kittanning middle about 2½′ thick. The Kittanning lower varies from 2½ to 4′ and the Brookville bed from 2½ to 3.

In Knox twp., the Kittanning upper bed at Reuben Caldwell's shows a top bench 3′ 4″ thick separated by 2″ of fire clay from a thin lower streak

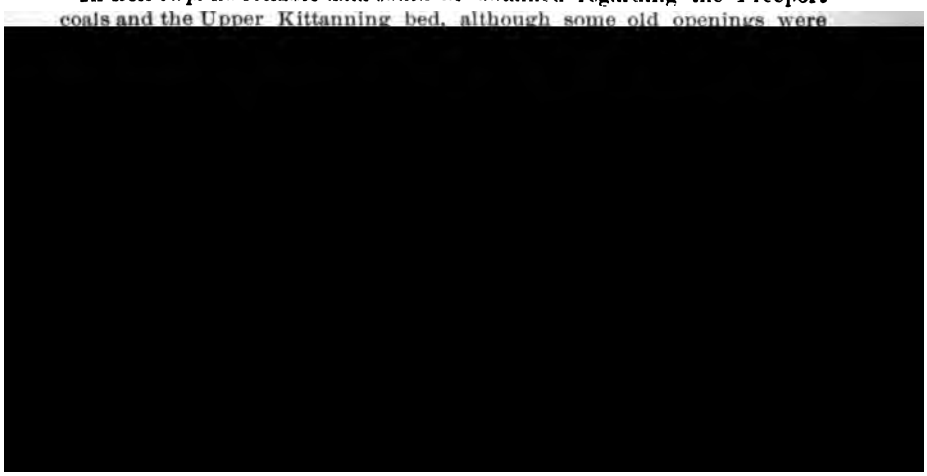
of coal 2″ thick. Bed C′ has a local thickness of 4′ but not averaging much over 3′; bed C ranges from 2′ to 3′ and bed B about the same, locally reaching 4′. Bed A 2′—2½′. In Boggs twp., the first axis crosses the Tyrone and Clearfield R. R. near Wallaceton. Two miles west of Blueball station the fire clay overlying the *Conglomerate No. XII* is extensively worked. Several coal banks are opened in this vicinity on the Kittanning coal beds: but none of them show coal of good thickness, the beds ranging from 2′ 8″ to 3′ 3″.

In Bradford twp. the top of the Conglomerate No. XII is above water level on all the creeks and runs in the northern and western part. The fire clay workings are in the vicinity of Woodland. The Hope Works show a face of clay averaging about 5′ thick, with softer or more impure clay in the roof and floor. The Woodland works show 4′ to 5′ of good hard clay, the bed varying rapidly and in places being pinched. A small 3″ or 4″ coal overlies the workable clay layer. Analyses of this hard clay bed at both these places show as follows: (McCreath).

	Hope.	*Woodland.*
Silica,	46.250	45.450
Alumina,	37.500	35.125
Protoxide of iron,	1.935	2.275
Lime,	.168	.168
Magnesia,	.126	.342
Alkalies,	1.115	1.290
Water and organic matter,	13.540	13.730

Most of the country coal banks are opened on bed B or bed C, neither of which much exceed 3′ in thickness. The Kittanning lower bed B is frequently reported 4′ to 5′ thick, although rarely yielding more than 3′ of merchantable coal. In Graham twp. the Hubler bank shows characteristic structure of bed B: bony coal 1′ 0″; coal, upper bench 3′ 3″; fire clay shale parting 1′ 0″; coal, lower bench 1′ 0″. Analysis shows 67% fix. car.; 25½ % vol. mat.; 2.479% of sulphur and 4.780% of ash. Bed C′ locally 6′ (?) thick, but with bad slaty partings. Bed C ranges from 2′ to 3′ thick. Bed A commonly 2½′ to 3′ thick.

In Bell twp. no reliable data could be obtained regarding the Freeport coals and the Upper Kittanning bed, although some old openings were



sandstone roof, sometimes slate; top coal 1′ 0″; slate 0′ 2″; coal 0′ 10″; bone 0′ 1″; coal 4′ 1″; slate 0′ 4″; coal 0′ 3″; total 6′ 2″. The coal shows very little sulphur; is bright and columnar, resembling the Houtzdale (Moshannon) coal. Miller's bank is thought to be opened on the same bed a ¼ mile east; but while there is here about 5½′ of coal the bed contains a parting 2″ or 3″ thick, about 3′ from the bottom. Hartshorn's, 1¼ miles southwest from the Davis opening, shows a coal from 4′ to 5′ thick, in two benches, the upper bench yielding a cannel-like coal and the lower bituminous coal. Kester's bank shows 3′ 6″ to 3′ 8″ with a small slate parting about 1′ from the bottom and with a roof similar to that at Hartshorn. Dr. Chance refers these openings to bed C′. East of Pennville and Little Anderson creek all the upper coals seem to be of small size. Bed B shows from 5′ to 6′ thick on the Daily place but is probably much smaller in other parts of the township. Bed A is reported 3′ thick. From recent investigations it seems probable that the Hartshorn, Kester and Mason G. Bloom openings are on the Kittanning upper coal C′ and that the Davis and Miller banks are on bed D.

In Pike twp. bed C′ shows 3′ 4″ thick, underlaid by 2′ of fire clay and 2′ of limestone (cement). An interval of 35′ occurs down to bed C, reported 2′ thick. The Kittanning upper coal is the bed on which nearly all the banks are situated and it usually carries from 2″ to 4″ of bony coal on top: an upper bench 2′ 2″ to 2′ 8″; a sulphurous slate parting 2″ to 3″ thick and bottom coal 6″ to 10″ thick. The bed furnishes a bright, black, shining, columnar coal with only a small amount of sulphur and ash, and is naturally good. Around Curwensville country banks have been opened on beds A and B, but they rarely show over 2½′ to 3′ of coal and generally of poor quality and sulphurous. In Lawrence twp. all the coals have been opened and worked, but most of the openings have fallen shut except those on bed C′, which shows usually an upper bench from 2′ to 2′ 4″ and a lower bench from 8″ to 10″ separated by slate from 1″ to 3″ thick. Bed C furnishes good coal but it is rarely more than 2′ thick. Bed B somtimes exceeds 2′ but often contains a thick parting of slate which sometime measures 10″. The beds are everywhere quite persistent and while of workable thickness, they are rather too thin to compete at the present time with more favored localities to the east and south, where the coal is 4′ and over thick. Important deposits of fire clay have been found and worked at the town of Clearfield. The hard clay bed averages about 4′ thick, with soft clay of varying thickness above and below it. An interesting suite of analyses will be found in H 7 page 175 et. seq. from which the following summary is presented:

Where the clay was opened in the mine for working at the time of the examination (July, 1874,) it showed:

Top clay and sandstone,	4′	0″
Smooth clay,	2′	6′
Coarse plastic clay,	2′	6′
Coarse plastic clay,	1′	6″
Hard clay, used for terra cotta ware,	4′	1″
Clay,	2′	3″

Carbonate iron ore balls in clay.

The bottom clay layer of this section shows great irregularity, making a waving floor, the layers above, however, being more smooth and even.

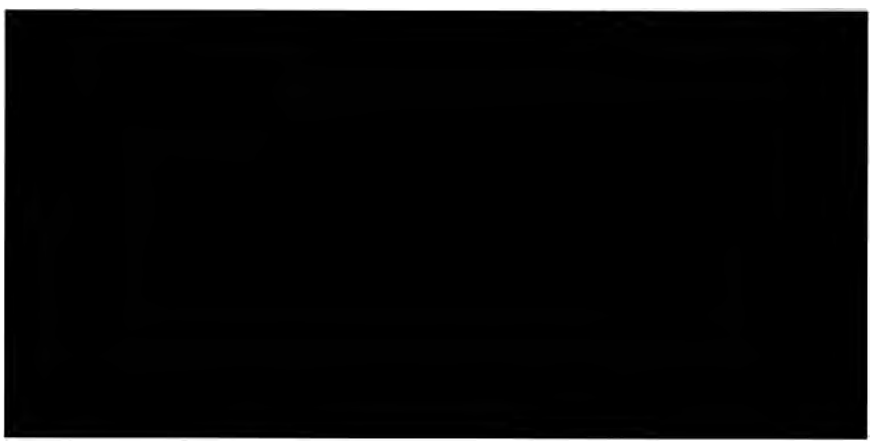
A full suite of specimens of this Clearfield fire clay yielded on analysis:

	1.	2.	3.	4.	5.	6.	7.	8.
Silica,	60.130	64.850	50.150	67.950	57.875	53.560	61.080	51.360
Alumina,	25.710	23.770	35.600	20.150	27.005	28.820	25.800	31.250
Protoxide of iron,	2.371	1.218	.845	1.980	2.549	2.243	2.347	1.936
Bisulphide of iron,	.067	.032	...	...	.033	.135	.064	.748
Titanic acid,	...	...	...	...	...	...	...	.509
Lime,	.117	.190	.112	.084	.112	.431	trace.	.061
Magnesia,	.663	.122	.160	.216	.465	.600	.530	.260
Alkalies,	3.490	.345	.070	2.045	3.170	1.800	2.800	.686
Sulphuric acid,	.191	.280	...	...	...	.869	.379	.261
Water,	7.280	9.560	13.610	6.580	8.305	11.406	7.732	12.382
	100.019	100.367	100.547	99.005	99.514	99.869	100.712	99.382

The value and uses of this clay and other fire clay deposits of Clearfield county is indicated in the following table (H 7 page 177):

Analyses of Clearfield Fire-clays.

		Silica.	Alumina.	Protoxide of Iron.	Titanic Acid.	Bisulphide of Iron.	Lime.	Magnesia.	Sulphuric Acid.	Alkalies.	Water, &c.	Total.
Sandy Ridge,	1.	44.950	37.750	2.700	....	...	.302	.216	.075	.985	13.050	100.028
	2.	45.650	34.730	3.546	....	...	.112	.619	.165	5.750	9.650	100.222
	3.	45.820	35.950	3.330	....	...	.112	.573	...	4.130	10.130	100.045
	4.	74.950	15 940	1.899	....	...	.106	.407	.050	1.756	4.885	99.993
Blue Ball,	1.	42.700	37.600	2.385	2.500	...	.112	.270	...	.730	13.840	100.137
	2.	43.350	37.550	2.145	2.825	...	.084	.234	...	.235	14.170	100.593
	3.	44.550	39.000	1.440	1.700	...	.028	.072	...	.530	13.660	100.980
Clearfield	1.	60.130	25.710	2.371	....	.067	.117	.663	.191	3.490	7.280	100.019
	2.	64.850	23.770	1.218	....	.032	.190	.122	.280	.345	9.560	100.367
	3.	50.150	35.600	.845	....	...	.112	.160	...	.070	13.610	100.547
	4.	67.950	20.150	1.980	....	...	.084	.216	...	2.045	6.580	99.005
	5.	57.875	27.005	2.549	....	.033	.112	.465	...	3.170	8.305	99.514
	6.	53.560	28.820	2.243	....	.135	.431	.600	.869	1.800	11.401	99.869
	7.	61.000	25.800	2.347	....	.064	Trace	.530	.379	2.800	7.722	99.712
	8.	51.360	31.250	1.936	.509	.748	.061	.260	.381	.035	12.382	99.362
Woodland Station,	1.	46.180	36.880	2.250	....	...	.173	.317	.009	2.760	11.580	100.149
	2.	45.230	36.030	1.980	....	...	.163	.257	.013	.830	13.605	100.088
	3.	46.250	37.500	1.985	....	...	.168	.126	...	1.115	13.540	100.634
	4.	45.450	36.125	2.275	....	...	.168	.342	...	1.290	13.730	99.380



a large area all through the southern end of Clearfield Co. and far north in the Third Basin.

*No. XIII in Cambria County.**

Structurally the main features of Cambria Co. geology are the *Viaduct* and *Laurel Hill anticlinal axes*, both of which are more distinctly marked along the Penna. R. R. than in the territory north of Ebensburg.

The first divides the *First* and *Second basins*, well seen at the great bow in the Conemaugh river between South Fork and Mineral Point. This axis is offset to the east approaching Somerset Co. and is lost under the great cover of Barren Measures northwards towards Ebensburg, where it is again offset to the east and passes through Chest Springs and St. Augustine to Clearfield creek above Flynn City. The *Laurel Hill anticlinal*, dividing the Second

---

to hold a thickness of 4' or 5' from openings in Goshen and Covington twps. An inter-conglomerate coal has been found in Bald hill, 3' thick, formerly extensively mined.

In Karthaus twp. bed B is reported 4' thick at many localities, occurring about 140' below bed D at Karthaus, where the intermediate Kittanning upper bed C' is thin. The northern part of the township, like Covington, is a conglomerate waste, uninhabited and unimproved, with its geology obscure. In the Third Basin townships, Huston, Union and Brady, the lower coals have been sparingly opened, this region lacking transportation facilities until lately. In Brady twp. bed B is generally a double bed with an upper bench 2' 4'' to 3' 0' thick; a clay parting varying from 4'' to 3' and a lower bench 1' 6'' to 2' 0'' thick. It sometimes carries bony coal on top. The Pentz bank shows 3'' of top bone and 2' 2'' of coal, and at Kopp's 6'' of bone and 3' 0'' of coal.

*The developments which have taken place during the last 20 years in this county, since the report upon it was written by Mr. Platt, have rendered a total revision of its detailed geology more necessary than in perhaps in any other district of the State.

The mining activity along Chest creek and in the Carrolltown district; at Hastings, Barnsboro, Spangler and along the various tributaries of the Susquehanna river, and the many new operations along the South Fork and Yellow creek south of the Penna. R. R. have served to bring about the greatest development in the *Lower Productive Coal Measure Group* of this county and to render its output even greater than that of Clearfield Co. Lying immediately to the south-west of Clearfield, it naturally partakes, in its structure and geology, of the prevailing characteristics of the older district, although the various coal beds of the *Allegheny River Series* vary in importance and structure to even a greater extent in Cambria than in either Clearfield or Somerset, north and south.

and Third basins, is distinctly marked by a high ridge, reaching elevations as great as the Allegheny mountain. It crosses the Conemaugh river near the Westmoreland Co. line where it lifts to daylight the *Catskill sandstone and shales No. IX;* but declining in strength northeastward, it reaches Black Lick creek 1 mile above the Big Bend with a slight exposure of the *Mauch Chunk red shales No. XI;* passes just west of Carrolltown and through St. Boniface to Clearfield Co. The *Nolo anticlinal* occupies a limited area in the extreme north-west corner of the county, crossing the river at Garman mills; and between it and the Laurel Hill axis lies the *Westover division** of the Third Basin, holding the important coals of the Susquehanna River district.

The *Lower Productive Coal Measures* likewise develop some unique features in this county, and the variation in total thickness in this group is very marked. Both these changes seem to occur through the central belt of the county; that is to say, that in the northern half of the county the entire group, between the *Mahoning sandstone* and the *Conglomerate*, is considerably thinner than it is along the Penna. R. R. and the Somerset Co. line; and in the same manner the enormous output of coal from each end of the county is largely obtained from different beds, the *Lower Freeport* or *Moshannon seam D* in the north end of the county, while along the Penna. R. R., the *Up-*

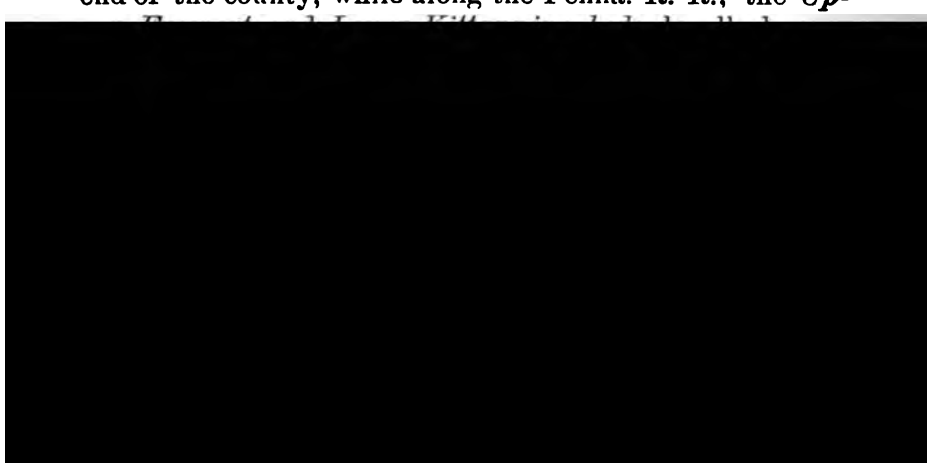
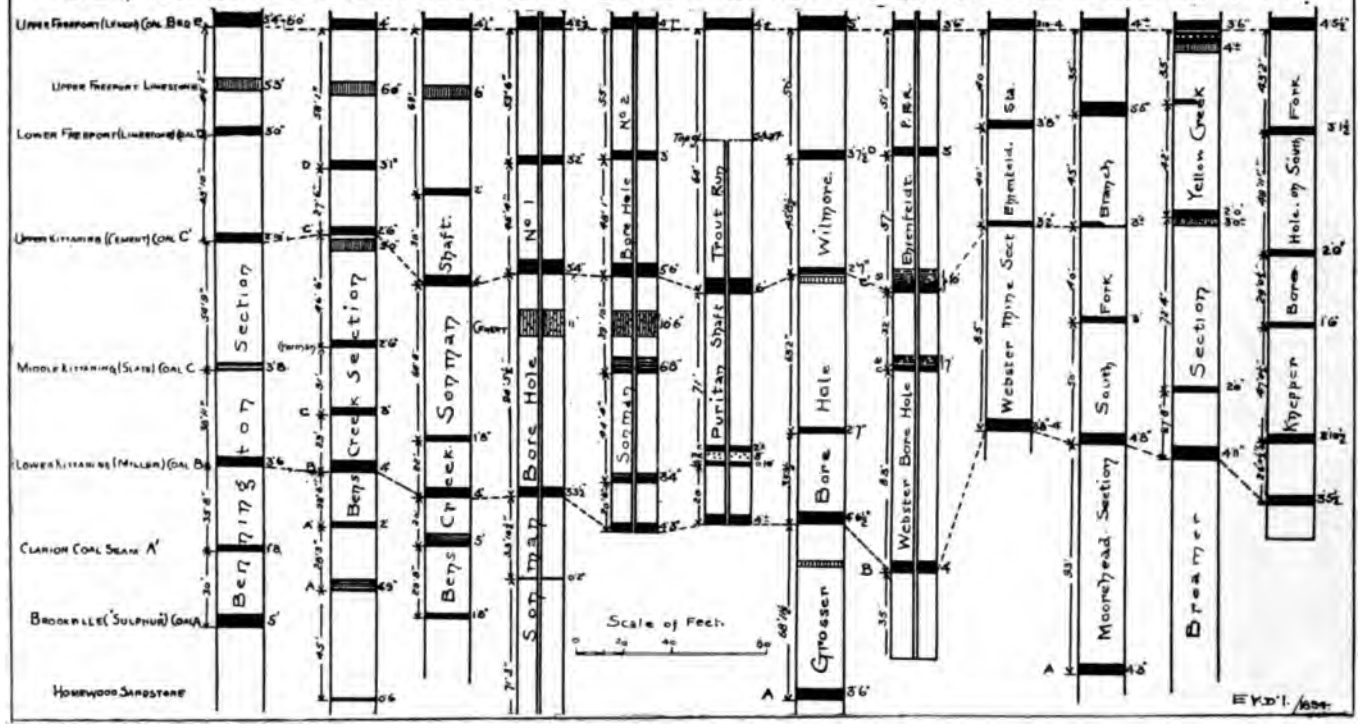


PLATE 414.

GEOLOGICAL COLUMNAR SECTIONS IN CAMBRIA COUNTY.





taning coal C', or *Cement seam* of Johnstown, although a large number of observers are inclined to regard it as the *Lower Kittanning bed B*, existing with a larger and better section than almost anywhere else in the First and Second Basins west of the Allegheny Mt. Perhaps the most complete and representative section‡ of this group along the Penna. R. R. was compiled by Mr. Fulton and verified by Mr. Platt, at Bennington in Blair Co. In order to show more clearly the variation in character and interval of the various coal beds in the Lower Productive Measures in the southern portion of the First Basin in Cambria Co., I have placed side by side with this *Bennington section* a series of sections along the Penna. R. R. and the South Fork, all oriented on the *Upper Freeport* or *Lemon seam E*, to render more easy the comparison just referred to. (Plate 414.)

In the *Brubaker region* and along the Susquehanna the interval between the top and bottom beds, E and A, is only about 200′; in the *Carrolltown-Patton field* on the east side of the Laurel Hill axis it is about 235′; at *Bennington* 250′; at *Sonman* 265′; at *Wilmore* 275′ and at *Johnstown* in the *Second basin* 250′. Recent surveys in the new *Black Lick field* indicate this productive group of coals to have an average thickness of about 300′; and it is this unlooked for increase in the interval between the upper and lower beds, together with the strong inclination of the coal measures bordering on the Laurel Hill axis, that has increased the liability to error in indentifying the various coal beds in that section at the present time. However the interval between the top thick coal opened along the Black Lick and the principal four foot mining bed upon which most of the openings have been made is nearly constant at 180′, so that when compared with other vertical sections throughout the *First* and *Second Bituminous coal basins* in this county the inference naturally follows that these coals are beds E

‡ The reader must be careful to note the necessity to revise the names and letters of coal beds in all sections prior to plate CCLXXXIX on page 1820, which plates have been reproduced in the early pages of this report by Prof. J. P. Lesley without any correction, from the original county reports. This remark does not refer to the revised plates in this report, subsequent to plate 396.

and B; thus correlating them with the "*Lemon*" and "*Miller*" seams of southern Cambria and Somerset Cos.

The whole character of the "*Black Lick Seam*" is totally unlike the appearance of the *Kittanning upper bed C'* as exposed anywhere in Clearfield, Cambria or Somerset Cos. On the other hand its double structure, columnar cleavage, partings, roof and floor, and excellent chemical character, most strongly resemble the features of the *Kittanning lower bed B* or *Miller seam*, all through southern Cambria and especially in the Paint and Shade creek valleys of Somerset Co., to be presently reviewed. At no place in the *Black Lick region** has the cement bed been noticed beneath this coal, which would identify it as bed C'.

In the *First basin*, along the Penna. R. R. from Bennington to South Fork, the only two commercial beds which are recognized as being sufficiently thick and pure to work are the *Freeport upper* or *Lemon seam E* and the *Kittanning lower* or *Miller seam B*, the *Upper Kittanning* (*Cement seam*) *C'* being found locally of workable thickness and character, especially along Ben's creek and Trout run, although never approaching the purity or excellence of the two other beds. This coal varies from 80' to 100' in interval from the Upper Freeport coal bed E.

Recent developments near the eastern rim of the basin, well up the South Fork branch, have pointed to the possibility of the *Brookville coal A* or lowest seam of the ser-

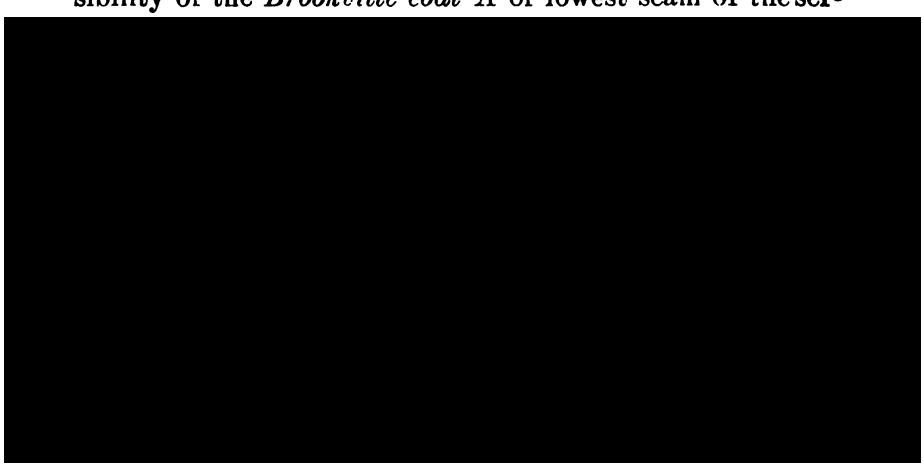
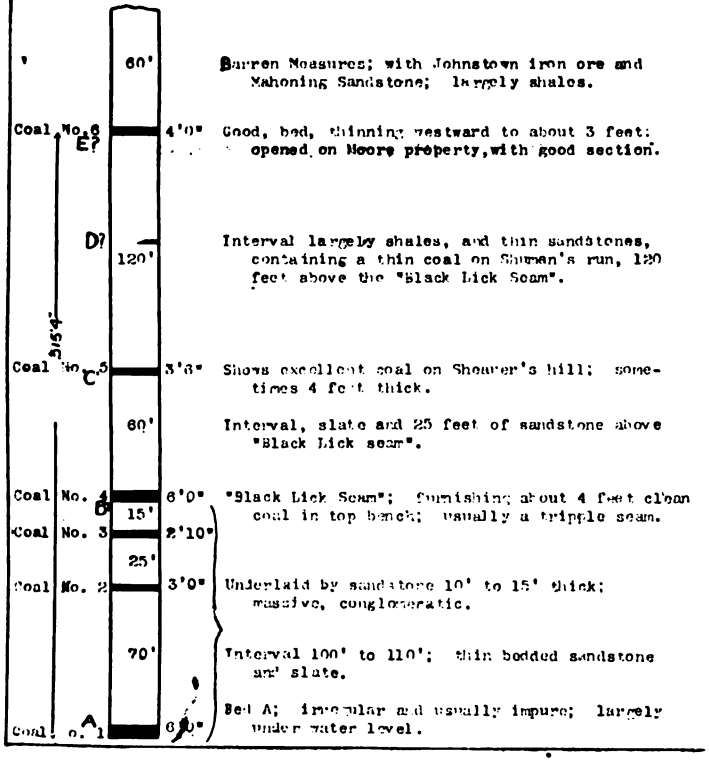


PLATE 415.

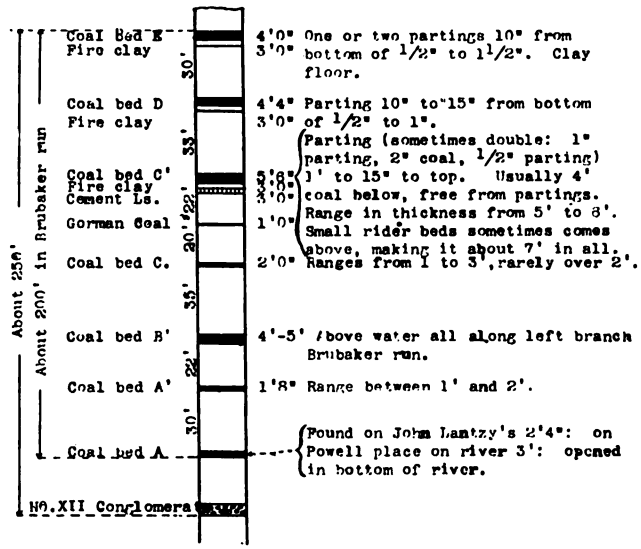
General Vertical Section; Big Head of Black Lick.



No XIII. Allegheny Coal Series in Cambria Co. Pa.

Vertical Sections in the Third Basin. Scale 100 = 1".

Section compiled near Hastings, Cambria County, Pa





ment and wide spread test of the coal marketed from this lower end of the county has likewise brought about a *commercial classification*, pretty thoroughly substantiated by a large number of analyses in the laboratory and in practice, so that for all steam and smithing purposes the palm is readily yielded to the *Miller seam* or *bed B*, which under the name of the "*Sonman coal*" finds a ready market all through the east, west and south-west, besides yielding a most excellent character of coke as mined on the Allegheny Mt. at Bennington. It is nearly everywhere in this field a first class bituminous coal, with a low sulphur and ash and a high percentage of fixed carbon, and around Bennington its coking qualifications are increased by its having 28% of volatile matter as against only about 18 or 20% in the territory around South Fork and Johnstown.

The *Upper Freeport coal E* is the next best coal of the series, as a rule but slightly inferior to the Miller seam, but not so desirable for smithing and rolling mill purposes by reason of its higher sulphur. As compared with fuels which go to tidewater markets from northern Cambria, Clearfield, Jefferson and Indiana Cos., with possibly the single exception of the *Moshannon coal bed D* of the Clearfield district, in northern Cambria and at Punxsutawney and Reynoldsville, this Upper Freeport coal maintains an excellent reputation and would be much more vigorously mined along the main line of the Penna. R. R. but for the presence and accessility of the superior Miller coal.

The *Upper Kittanning coal C'* has been worked at three collieries on Trout run where it shows a coal 6′ more or less thick, of which 3′ 8″ to 4′ is good coal, in one bench, though inferior in quality to both the Lemon and Miller seams on the same stream. The two Sonman bore holes report this coal 5′ 4″ and 5′ 6″ thick; but these records are somewhat doubtful from the character of the drilling. The new shaft recently completed (July, 1894), gives a more correct interpretation of this coal, with top bony coal 3″; good coal 8″; slate 10″ and bottom coal 3′ 3″; total 5′ 0″. The same shaft records bed E 4′ 2″ thick, of which the top 6″ is slate and

bone, and 1″ of slate at 15″ above floor. Bed D shows a strangely increased section over its general worthlessness along the Penna. R. R., in all 5′ 10″ thick, and only 3″ of bone on top. It occurs 52′ below bed E and 42′ above bed C′. Bed B is again the best coal, 4′ 3″ thick, of which 2″ on top is bony. The section (plate 416) fails to show the presence of a single limestone bed. Bed B is 94′ 8″ below C′; the latter (Upper Kittanning seam) rarely shows the section or character displayed in this neighborhood.

At Bens creek it is 4′ thick, while at Bennington and South Fork station, on the opposite rim of the basin, it is but 2′ 10″ and 2′ 2″ thick. In the same belt of territory bed E varies from 3′ 6″ to 6′ 0″ in thickness, yielding an average of 4′ of merchantable coal, while bed B shows a thickness of 3′ 8″ to 4′ 11″, with about as great an average yield of commercial coal as the higher bed. It frequently carries bony coal on top.

The *Bennington mines* show a group of openings near the station of that name on the Penna. R. R. all on the Lemon and Miller seams. Bed A was once worked here by the Cambria Iron Co., 5′ thick, but soon abandoned on account of its high percentage of sulphur. Bed B, in a state of great purity and excellence, shows from 3′ 6″ to 4′ thick, everywhere a double bed with a parting of hard clay, yielding about 3′ 8″ to 3′ 10″ of coal. Bed E shows a thickness of 5′ though perhaps not averaging over 4′ of commer-

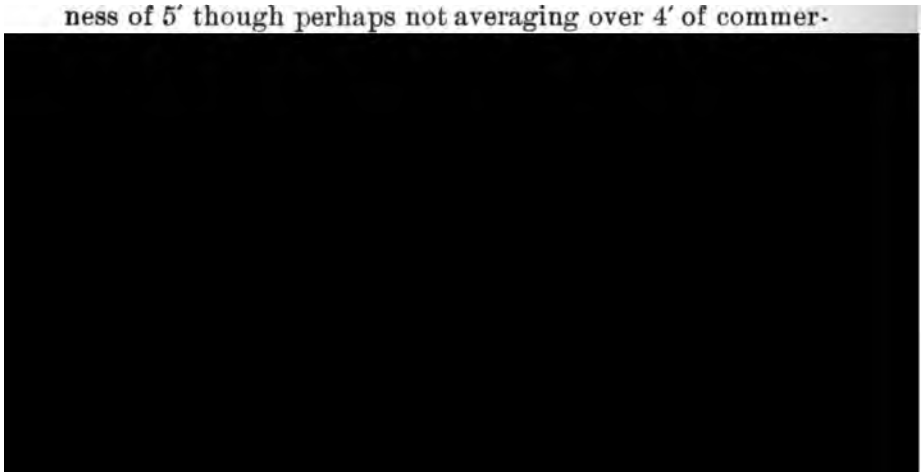
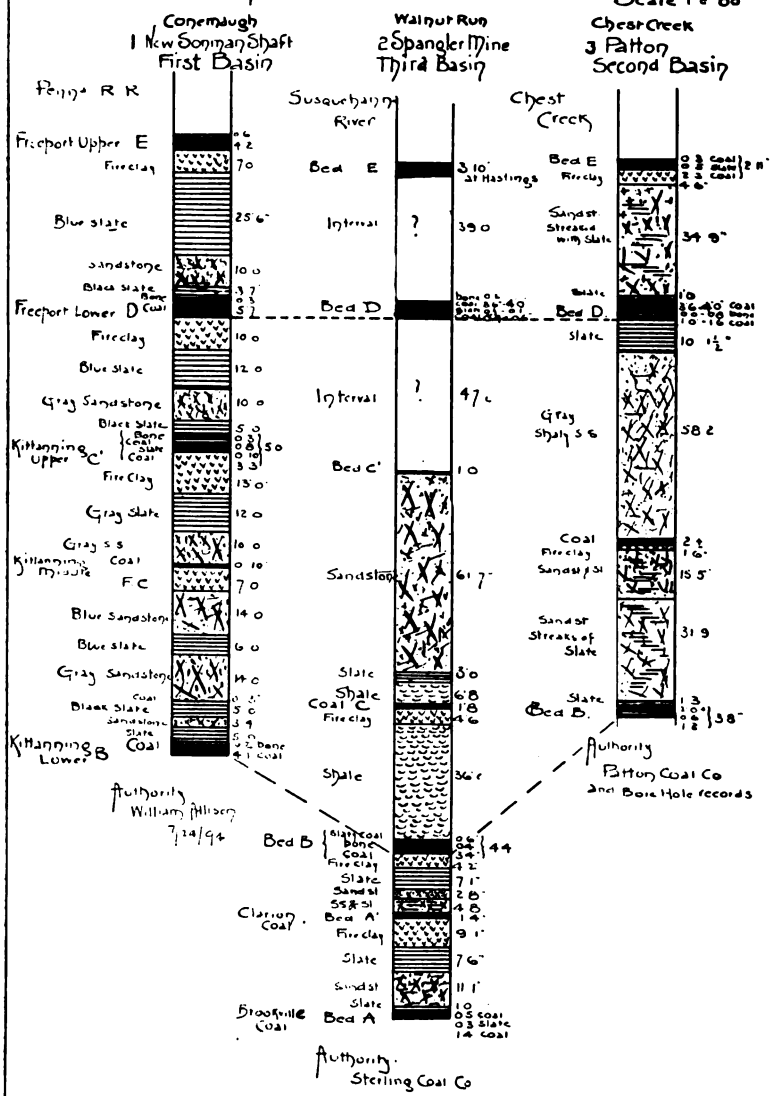


Plate. 416.

No XIII Allegheny Coal Series in Cambria Co Pa

Comparative Vertical Sections

Scale 1" = 60'



EVd I



tinctly different in the Bennington district from that around Sonman and South Fork, though the principal difference lies in the proportion of hydrocarbons to fixed carbon. In both districts the percentages of sulphur and ash are quite similar, an average of bed E yielding about 1% of sulphur and 8% of ash and bed B .5% to .8% of sulphur and 6% of ash; but at Bennington both of these coals carry from 25% to 28% of volatile matter whereas further west, towards the Viaduct, they do not yield over 18%. Many analyses of bed B at Portage, Sonman and South Fork do not show over .5 of 1% in sulphur and not over 6% of ash, and if this exceptional analysis is not always maintained in the output of "run of mine" coal, the reason is largely ascribable to failure in separating the bone coal which frequently accompanies the top bench of this bed.

These same beds, occurring through the eastern side of the *Wilmore* or *First Basin*, from Bennington to Trout run, appear above water level in regular order, only with a reversed south-east dip, from Summerhill to the Viaduct, where the anticlinal axis dividing the two great coal basins of this county crosses the Conemaugh river. The *First Basin* is 6 miles wide on its eastern slope and but 4 miles on the western, the axis line of the trough passing a little west of Wilmore to the South Fork of the Conemaugh near the mouth of Muddy run, its course being about S 26° 30′ W or practically parallel to the water level lines, as determined between Trout run and Bens creek. The central part of the basin is wide and flat, sinking gently* (22′ per mile) towards the south-west; and though

*This tendency to *sink south-westward*, noticed so frequently in all the Bituminous basins of Western Pennsylvania, nevertheless has some important modifications. Thus here in Cambria Co., the First Basin, comparing the elevation of anyone coal bed, certainly follows the rule from the Clearfield line to the Penna. R. R., the total fall south-west approximating 400′; but between the two branches of the Conemaugh the basin seems to be practically level, while from the South Fork south-west 8 miles to Scalp Level on the Somerset line, the measures *rise* fully 900′ or over 100 a mile, so that Bed B, deeply buried on South Fork, outcrops 40′ above water level on Paint creek in Somerset Co. From this point the basin gradually slopes again south-west towards Stony creek and the Quemahonlng creek.

the Lower Productive Measures exist in the bottom of this trough at a considerable depth beneath the Barren Measures, a number of bore holes have revealed the integrity of the entire system, so that at no very distant day, this belt of territory between the Conemaugh and the South Fork may be confidently expected to yield an enormous tonnage of these high grade steam and smithing coals, when it shall become necessary to locate shafts there.

The *Webster Colliery No. 3* (J. C. Scott & Sons,) is the first operation met with on the west side of the basin, and is one of the largest in the region. Although the Lower Freeport D, Upper Freeport E and Upper Kittanning C′ beds are all opened in the vicinity of Ehrenfeld station, the preponderating excellence of the *Miller seam bed B* has caused mining to be restricted entirely to this bed at all the operations around South Fork. It seems strange that the great Moshannon seam bed D of Clearfield, Jefferson and northern Cambria should be represented all through the southern section of the county, in both the *First* and *Second Basins*, by a bed rarely 3′ thick and commonly yielding but 2′ of coal, characterized by being frequently underlaid by the Freeport lower limestone. The thickness and purity of bed B however along the Penna. R. R. and southward into Somerset Co., fairly compensates for the loss of the Moshannon seam, especially as the character of its fuel is regarded with equal favor and the area underlaid by this

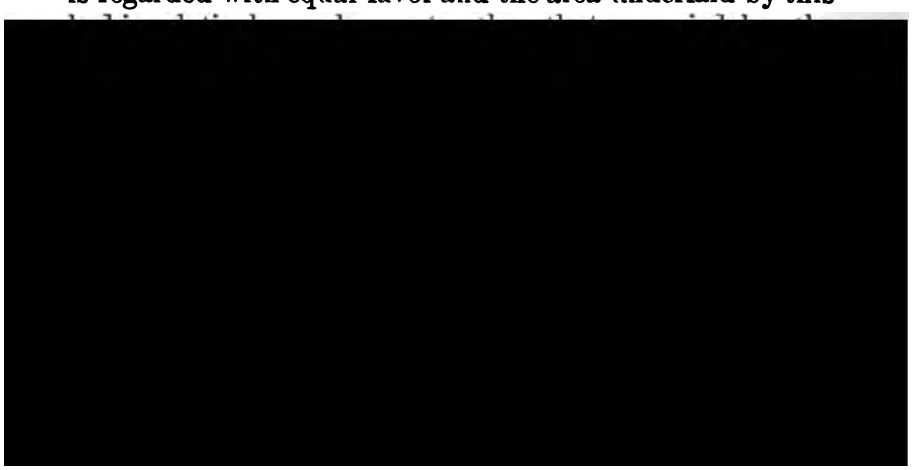


PLATE 417

No XIII Allegheny Series in Cambria County, Penna

Coal Bed Sections in First Basin



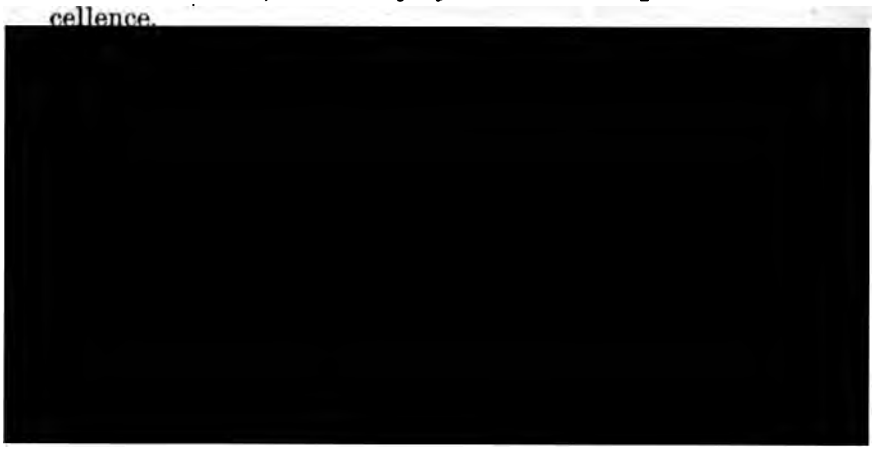
Bed E shows from 3′ 10″ to 4′ 1″ thick, with 2″ of slate at about 1′ 6″ above the floor. Bed D is in better condition than usual here, showing from 3′ 2″ to 3′ 6″ thick as against 3′ on Bens creek and 3′ 7½″ in the Grosser bore hole at Wilmore and 3′ 1½″ at the Knepper bore hole on the Muddy Run branch of South Fork. In the *Stineman mines*, near South Fork station, bed B varies from 3′ 6″ to 4′ 0″, with sometimes a little bone coal on top and separated by a variable parting (3″ to 2′) of fire clay from a sulphurous bottom bench of coal 10″ thick. The main bench is alone mined at all mines mentioned, and at the Aurora, Argyle and Euclid mines.

In the *Argyle opening* the Viaduct axis has been reached at a distance of 3600′ west from the main entry, and a "fault" of inferior bed section is mentioned as occurring in the mine, running N 33° E in the direction of the main heading and about 2100′ west from it, in which for a width of 350′ the coal carries a sandstone floor and the upper 2′ becomes of cannel structure. West of this "fault" the coal yields a normal 3′ 6″. At the *J. C. Stineman mine* on South Fork bed B varies from 2½′ to 5′ in thickness; but it maintains its excellent chemical purity, a large sample taken in 1888 showing fixed carbon 76.791; vol. mat. 16.485; sulphur .774; phos. .003 and ash 4.860.

Developments along the South Fork have been more active since the extension of a railroad up that stream to the eastern margin of the First Basin, and sections at Dunlo on Yellow creek and on the Moorhead tract on South Fork (see plate 414) will suffice to show the characteristics of the measures here. The Upper Freeport E was first opened at the Henrietta mine at Dunlo, showing 3′ 6″ at the outcrop but thinning down 250′ in the mine to about 3′, with 1′ 8″ of good top coal; 7½″ of bony coal; 1″ to 3″ of hard bone or slate and from 6″ to 8″ of fair bottom coal. Below the latter there are benches of slate 2″ and coal 3″; but the whole seam was found much cut up and impure. Outcrop openings on the same seam south of the creek show the occurrence of limestone under this bed as well as the cement rock under the Upper Kittanning C′, which forms the bed of Yellow

creek for at least 100′. The compiled intervals between beds E and B is given at 170′, while the Upper Kittanning C′ lies 77′ below E and 100′ above B, the latter bed being under water level at Dunlo and mined by shafts.

Bed C′ has a thickness of about 2′ 10″; bed C about 3½′ as reported in the shafts, occurring only 15′ above bed B; and the latter (Miller seam) is about 5′ thick, in two benches; an upper 3′ 9″ and a lower 1′ thick separated by 2″ of slate. Its analyses again show a remarkably pure fuel, with F. C. 76.146; V. M. 15.522; sulphur .714 and ash 5.020. The bed is greatly rolled here, rising rapidly and irregularly up stream toward the mountain. The *Yellow run shaft* (Berwind-White C. M. Co.) is 196′ deep to bed B, and shows excessive dips and irregularities. The *Henrietta shaft*, 4000′ up stream southeast, is 65′ deep, the coal rising between these two points 282′. The same characteristics prevail here, only more emphasized if possible. Good but thin coal is mined, averaging 3′ 6″; irregular dips and swamps exist, the rolls in roof and floor sometimes reducing the section to 3′ 0″, and enlarging it to 5′ 0″; and in a large part of the mine the roof is sandstone, which is responsible for much of the trouble. In its *average condition* the bed carries a slate roof: bone coal 0″ to 2″; coal, mining bench 3′ 6″ to 3′ 8″; slate and bone 0′ 4″; bottom coal, impure 1′ 0″ to 1′ 4″; so that it still presents its characteristic double structure, and always yields a coal of particular excellence.



A large number of developments have been made on this hill which serve to show the character of the remaining beds of the group. Thus 35′ below the Upper Freeport opening, bed D (?) was measured by Mr. Wilson* of the Claridge Coal Co. with a total of 5′ 5″, thus comparing favorably with the splendid development of this bed in the Moshannon district of Clearfield Co.; but yet as it has not taken a permanent place in the South Fork field, and at this single opening shows an upper bench 4′ 3″ thick of good coal, separated near the middle by 2″ of bone and divided from a lower bench of somewhat inferior coal 1′ thick by 2″ of slate parting.

The First basin north of the Penna. R. R. has likewise been developed in a number of places along the Cresson and Coalport railroads, which closely marks the basin, between Ashville and Flynn City. None of the beds however seem to exist there with equal purity and excellence shown along Chest creek and the Susquehanna and along the Penna. R. R. and southward. Vertical sections in northern Cambria are given on plates 418, 419 and 420.

At Frugality, in the heart of the basin, the principal developments have taken place; but though openings have been made on several beds of the Allegheny series, only bed E, the *Upper Freeport*, amounts to any importance; and while it produces a fair quality of coal and with care, an acceptable coke, it never gives 4′ of clean coal, and throughout much of the No. 3 and 4 mines it will not average over 3′ 6″ thick, generally carrying 2″ of "cannel bone" on top and a small slate band about 1′ from the floor, thus leaving only 3′ 3″ of clean coal. This bed has been opened at Sandy run and at Van Ormer's, only 3′ 2″ thick and impure, and probably at the Beers and Notley country banks, showing 2′ 7″ thick with two binders, 2″ and 0½″

*The same authority reports bed B opened in two benches, showing 4′ of clean top coal and 5″ of bottom coal separated by 3″ of hard bony slate; and 93′ lower in the section. he reports an opening on bed A, showing 4′ 3″ thick with no distinguishable partings. He reports the two other Kittanning beds, C and C′, each 3′ thick, so that if this section is verified, it would indicate a most remarkable development of all the beds of the Lower Productive series in the upper South Fork and Yellow Creek district.

thick at 3″ above the bottom and 9″ below the top of the seam. At Patton's it is 2′ 4″ thick.

Hence there seems to be a tendency for this bed to thin away descending the creek from Frugality, at the same time becoming impure. The *Lower Freeport bed D*, 40′ to 45′ lower, is absolutely worthless at Frugality and Sandy Run; but just as the E coal becomes impure beyond, this D bed begins to improve and shows a better character down the creek, furnishing about 3′ of fair coal at Waffington mine, with a small binder 3″ above the bottom. Between Fallen Timber and Flynn City it is reported about 3½′ thick and it is evidently this bed which Mr. Patton has developed 3′ 3″ to 3′ 10″ thick with a 3″ binder about 8″ from the floor.

The *Upper Kittanning coal C*″ shows a workable thickness at Frugality; but it was found so impure that it is difficult to compete in the open market, either as coal or coke, with other coals in the county, a criticism even more applicable to the still more impure and thinner bed B along this portion of Clearfield creek. At the Glen White mines in Blair Co. where these coals outcrop on the eastern side of the Allegheny Mt., openings have been made on the *Lower Kittanning bed B* and *Brookville coal bed A*.

The latter shows 2′ 3″ thick with an additional 8″ of bony coal on top. Bed B shows a large double seam; but only the upper bench furnishes pure coal and is the only part of the bed mined for shipment. This bench is 2′ 7″ thick,

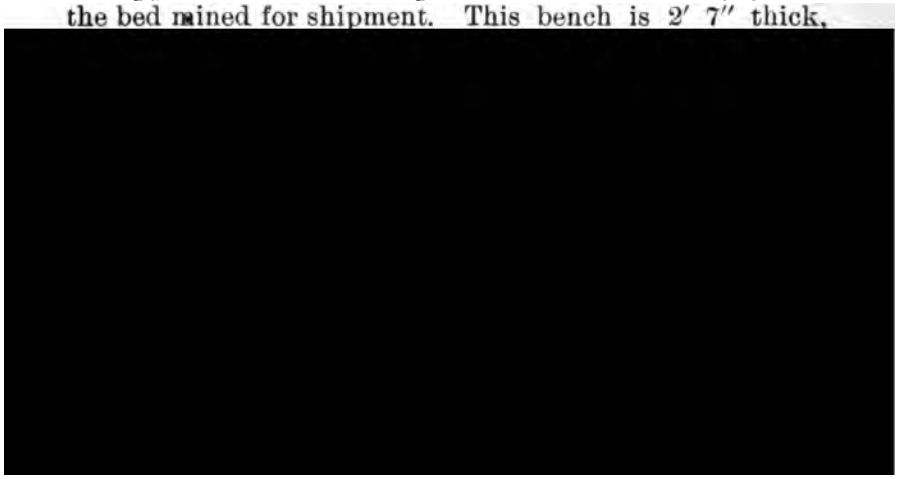
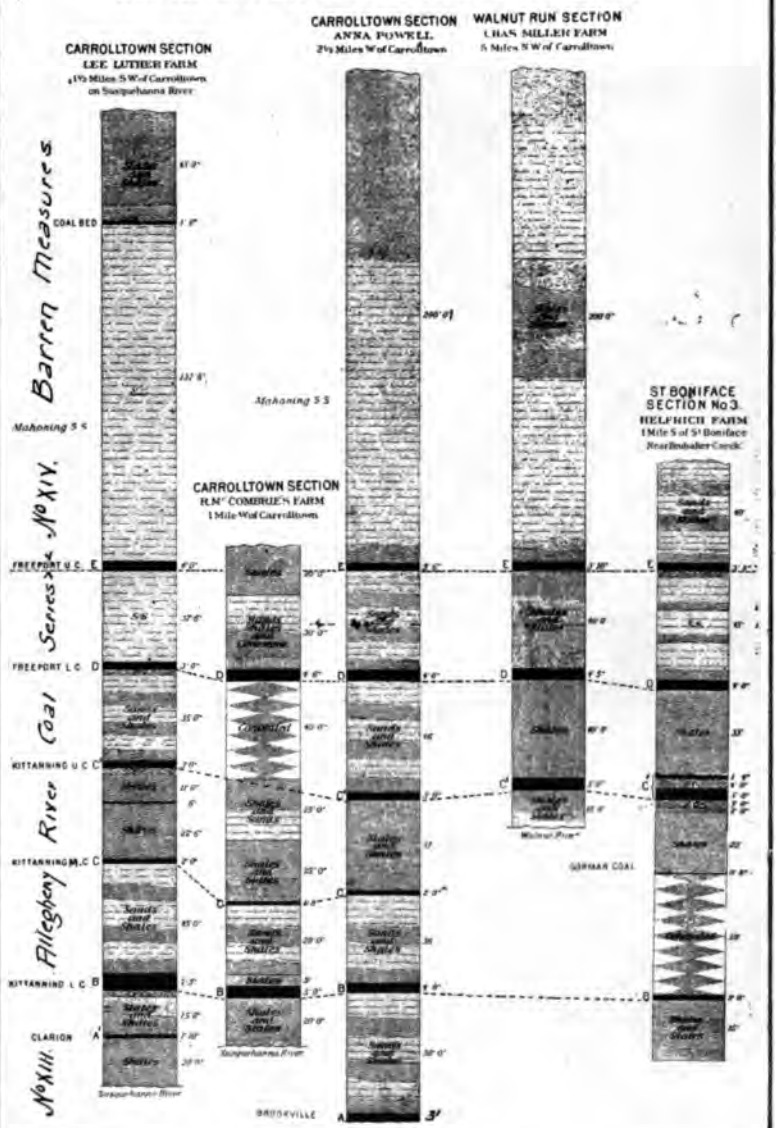


PLATE 418.

No XIII Allegheny Coal Series in Cambria County, Pa.

Vertical Sections in Third or Westover Basin





but the upper 2′ 6″ yielding an excellent steam coal with .983% of sulphur and 5.690% of ash.

The Bells Gap R. R. crosses through the north-eastern corner of the county, through the First Basin from Lloydsville to beyond Glasgow. In the Lloydsville mine bed B is divided into three benches, and yields in places as much as 8½′ of coal. The lowest bench however is both pyritous and slaty and the coal of little value; but the upper and middle benches are reasonably free from such impurities and produce a good strong steam fuel. The bed shows 3″ of top bony coal, capping the upper bench 2′ 6″ thick; then 6″ of fire clay shale, 2′ 6″ of coal, 3″ of fire clay and 1′ 8″ of impure coal. The quality of the whole bed however is inferior to that which this seam shows all through southern Cambria Co. Further north along the railroad this same bed B has been opened by Bland, Great Bend Coal Co., Eldorado and Frick, its outcrop swinging down Powell run and Big Muddy to the Clearfield line. The region is faulted and the bed has a varying thickness. On Powell run it is from 3′ to 6′ thick, often rolled and squeezed but always a double seam, with a thick central band of bone or fire clay slate. It overlies the Brookville coal A by 60′ to 70′, the latter seam usually dirty and sulphurous, and only opened at the Hommer mine on Big Muddy, where it shows a slate and sandstone roof; top hard coal 1′ 3″; slate 0′ 3″; coal 0′ 4″ to 0′ 6″; slate and bone 0′ 6″ and bottom coal 3′ 0″. It contains sulphur 1.667% and ash 9.765%.

At the above mentioned mines bed B averages about 4′ thick; a top bench 1′ 8″; slate and bony parting 4″ to 8″ and botton bench 1′ 10″; thus closely resembling its condition at Coalport and Irvona, in Clearfield Co. It is only a fairly good commercial coal, its unfortunate partings in this district increasing cost of mining and impurity of the product. It is totally unlike the same seam in southern Cambria Co. The two upper Kittanning coals are not found in good condition here.

The *Freeport group* is not present in the southern end of

this district, between Hommer's and Lloydsville, unless in one ridge south of Powell run, where the Scott coal is supposed to represent bed D, occurring 140′ above bed B and showing top coal 1′ 9″; bone and slate 2½″; coal 1′ 5½″; slate 0′ 2″ and coal 1′ 1″. The three coal benches yielded on analysis, water 1.120%; F. C. 59.209%; V. M. 25.445%; sulphur 3.133%, and ash 11.193%.

Around Mountaindale the Freeport group is present and is opened in several places north to Glasgow and down Fallen Timber run. Bed D has been worked at Mountaindale by Mr. Givin and the Union Coal Co., furnishing an excellent steam coal, although the bed averages only 3′ 2″ thick, with a thin slate parting 10″ above the floor. The same companies have opened bed E, which occurs 35′ to 44′ higher in the measures, but is only 3′ thick. The Bear Ridge C. & C. Co. at Glasgow have the best exposition of this seam, the coal varying from 2′ 8″ to 3′ 0″ thick, with a thin hard slate 6″ to 8″ above floor. The coal is excellent, and owing to a notable percentage of volatile matter (27½%) makes a first class coke. It carries also a low ash and about .75% of sulphur and only .008 of phosphorus. Both beds crop all through the Fallen Timber valley, though apparently not so pure in quality, while bed B can only be mined there by shafts 80′ to 100′ deep. In several places in this district, on Powell run and Big Muddy especially, there are excellent beds of commercial fire clay under-

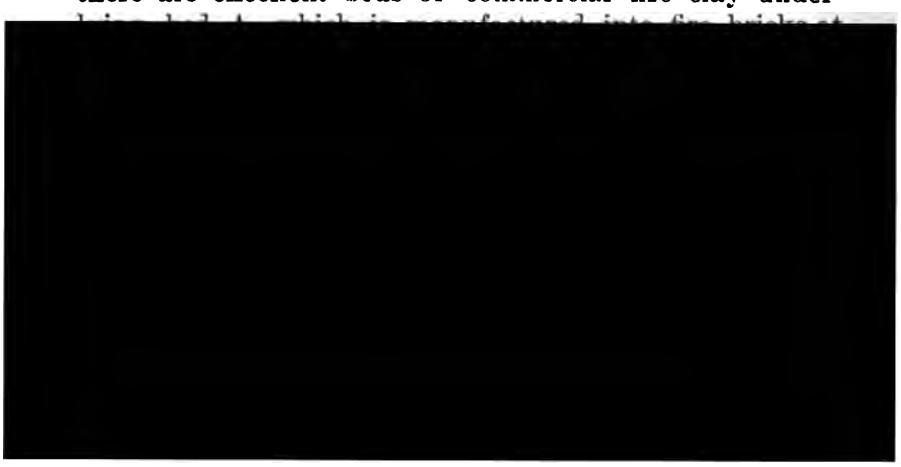
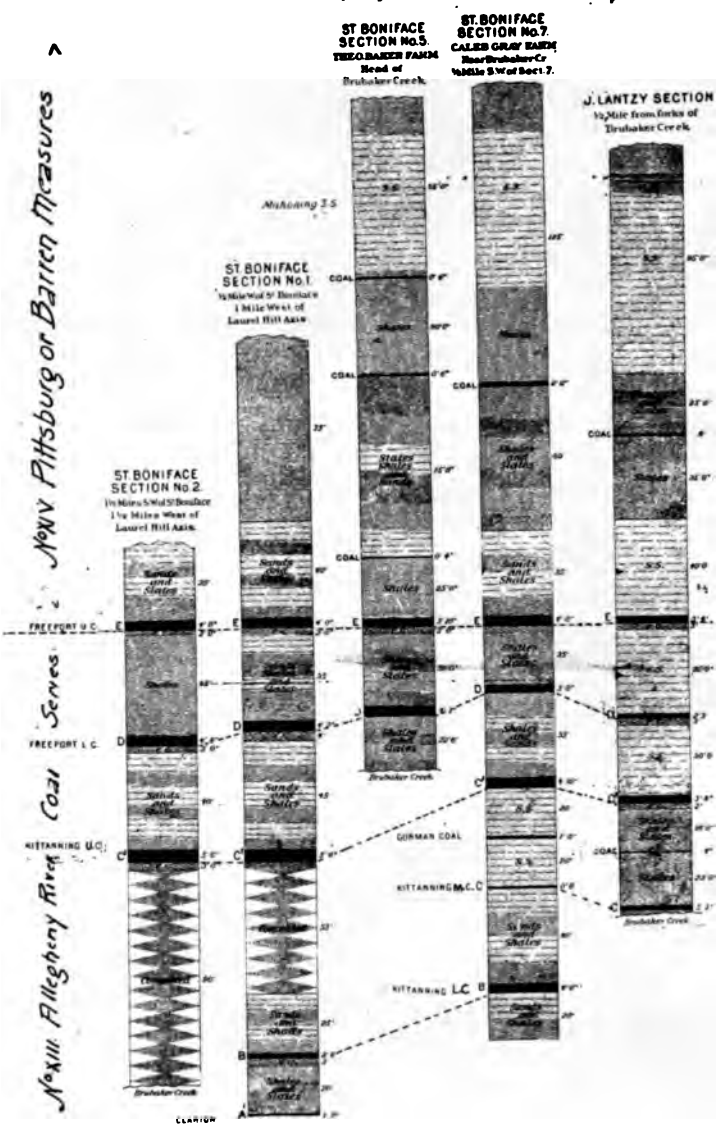


PLATE 419.

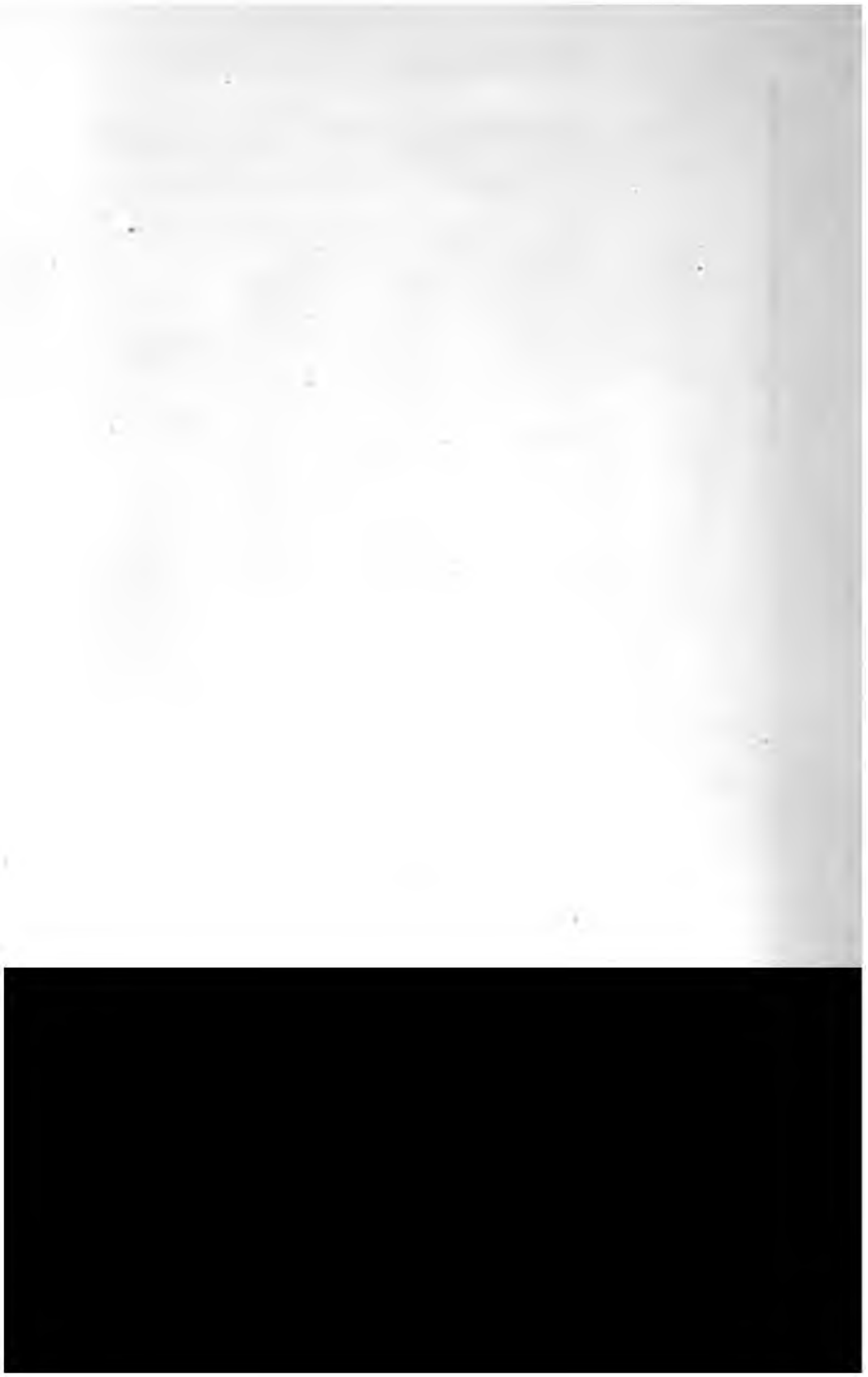
No XIII. Allegheny River Coal Series in Cambria Co. Pa.

Vertical Sections in Third or Westover Basin.



Scale 1 inch = 80 feet.

E.v.d'l.



a very large tonnage is extracted at the present time for the use of the Cambria Iron works.*

Around Johnstown the *Upper Freeport coal E*, "Coke Yard or Lemon seam" is 3′ thick; the *Lower Freeport*, or "Limestone seam D" 2′ 6″, with 3′ of limestone beneath it; the *Upper Kittanning C′* or "Cement seam" 3′ 6″, with 5′ 0″ of Ferriferous cement rock underlying it; the small Gorman coal between the two upper Kittanning beds 1′ 6″ thick; the *Middle Kittanning C* or "Slate seam" 9″ thick; the *Lower Kittanning B* or "Miller seam" 3′ 6″ thick and the *Brookville coal bed A* 6′ 10″ thick, with an upper bench 4′ 6″ and a lower bench 1′ 10″, separated by a slate 6″.

The *Freeport group* is geologically well developed around Johnstown although no coal seam in that region is as well known commercially as the *Upper Kittanning* or *Cement seam C′* which has furnished the bulk of fuel mined in this basin.

The *Upper Freeport bed E*, as developed by the Cambria Iron Co. along Hinckston run, was troubled with frequent rolls and horse-backs arising chiefly from an uneasy floor, and the main bench of coal is therefor at times considerably reduced in thickness. The bed carries in places 10″ of bony coal above a thin slate, beneath which the main bench varies up to 3′ 6″ thick with a thin slate near the floor.

The *Lower Freeport* D has never amounted to any im-

* A very complete, typical and standard vertical section of the *Lower Productive Measures* at Johnstown by Mr. John Fulton will be found in plate 420 of this report, where the *Barren Measures* in Prosser knob show over 300′ thick, largely shale and thin sandstone, containing some important beds of iron ore in and above the Mahoning sandstone member of that group.

The Mahoning sandstone shows in cliffs over the river and has also been quarried to a considerable extent when the carbonate iron ore was being mined for use in the furnaces.

The extensive ore diggings of the Cambria Co. in the hills opposite Johnstown and elsewhere, are almost entirely abandoned now, the company finding it more profitable and economical to purchase the higher priced but richer Lake ores. The ore bed is divided into two bands by a stratum of fire clay shale, ranging from 1″ to 1′ in thickness, and invariably underlaid by slate. The upper bench is richer in iron than the lower; but neither will yield over 30% of metallic iron in the furnace in the raw state. The average thickness of the bed was about 2′; it changes rapidly however, the upper band thickening as the lower thins and *vice versa*.

portance in this district; but the *Upper Kittanning C'* has been largely mined, yielding a bright hard coal, bedded in horizontal layers and averaging about 3½' thick. Bed B* at Conemaugh station shows 3' of excellent coal and further west 3' 6" with 2" of bony coal on top.

The most important fact brought out by a study of the Cambria Coal Co. coals, is the general superiority of the *Kittanning lower bed B* in the *First Basin* over the same seam in the *Second Basin;* and quite as important, the much greater purity of the *Kittanning upper bed C'* in the Johnstown basin over its condition in the Wilmore basin. Indeed these two coal beds simply change places in the commercial scale in these two basins, a well established fact, even if not satisfactorily accounted for; and the separating Viaduct axis closely marks the line of change.

In the immediate vicinity of Johnstown almost all the coal mined comes from the Upper Freeport and Upper Kittanning coal beds. Bed E frequently furnishes over 4' of good soft coal; but the bed is twice parted by thin bands of black slate, and crumbles in mining.

Bed C' possesses an average thickness of 3½', without persistent slate parting, usually presenting a solid breast of hard firm coal, overlaid by black slate and resting on a thin stratum of fire clay shale, beneath which is the "cement rock." The coal carries a considerable quantity of sulphur, occurring as segregated masses of iron pyrites, amounting to from 1.25% to 1.50% in the coal.

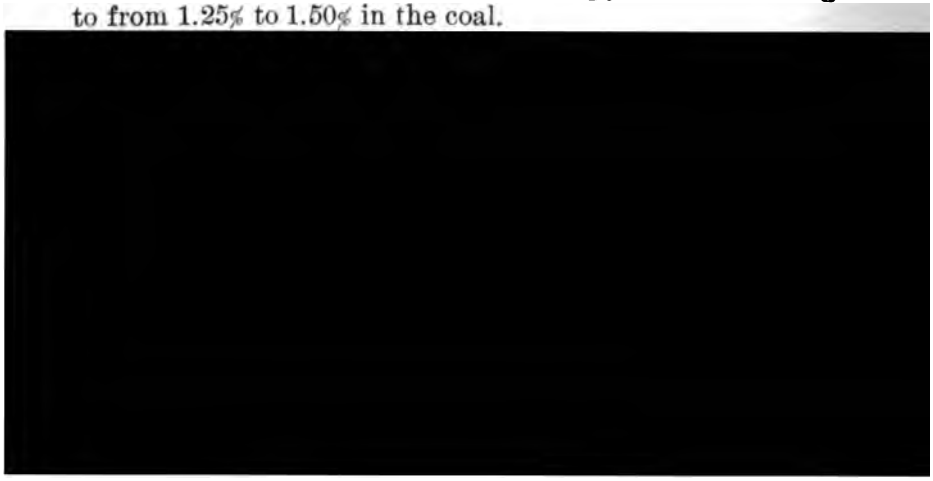


PLATE 420.

No XIII. Allegheny River Coal Series in Cambria Co.

Vertical Sections in the First and Second Basins.

Scale 1 inch = 80 feet



is only 2′ 8″ thick, of which the upper 2″ is bony coal; but at Coopersdale it is said to have measured 2½′.

Along Stony creek and its tributaries south of Johnstown, the same two beds, E and C′, have been opened at a number of places, bed B, the other workable bed of the series in this district, being largely under water level except where it is hoisted to daylight along the east flank of of the Laurel Hill axis.

The *Upper Kittanning C′* is still the most important seam of the district, lying closer to water level and the railroad and therefor more accessible to development. It is opened at the extreme southern end of Johnstown and in a number of places along the eastern bank of Stony creek, where the bed is about 30′ above water level, and corresponds in section with the bed along the Conemaugh east of Johnstown. The mining section varies from 3′ 2″ to 3′ 7″, frequently carrying about 2″ of bone coal on top.*

North of Geistown near the headwaters of Solomon's run bed C′ has been opened in a number of places, yielding nearly 3′ of good clean coal, varying from that up to 3½′.

The *Lower Freeport D* has been frequently opened for country use in this portion of the basin, more especially for the purpose of supplying local fuel for calcining the limestone underlying it than for the development of merchantable coal. The bed is everywhere thin, from 18″ to 2½′, and of no commercial value.

Bed A outcrops in the road at the Red Bridge,† and yields 3½′ of pyritous slaty coal.

North and east of the Conemaugh the coals in this basin

*On the Horner property at the Red Bridge close to Somerset line it becomes 4′ 3″, top 1′ soft coal: seam bedded in horizontal layers and breaks into cubical masses in mining: clean, without persistent parting and shows small amount of iron pyrites. At the Fry and Holsopple mines 4½′ of good coal, and at Jacob Holsopple opening 4′ 5″ thick, thin parting near center, not persistent. The coal is hard and firm and shows the cuboidal structure peculiar to bed C′ everywhere in the Johnstown basin.

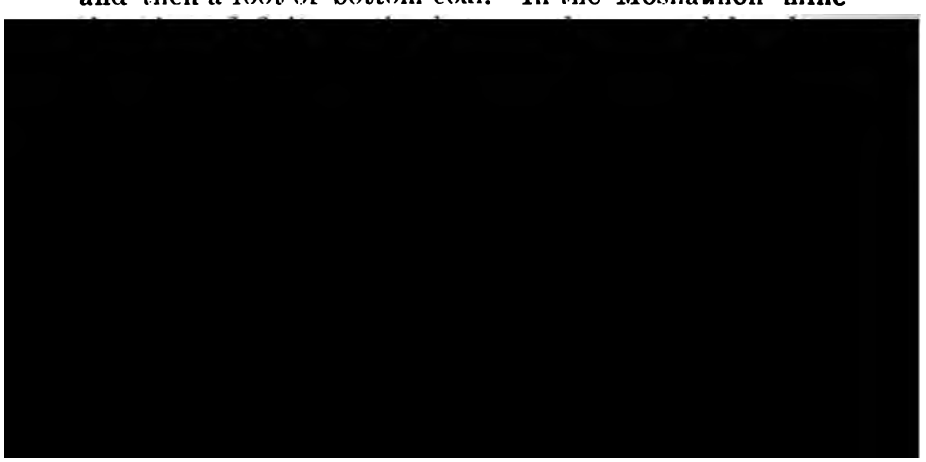
†East of bridge, near crown of Viaduct axis, 3′ 7″ thick in one continuous bench, opened on top of 75′ of massive sandstone, the top member of No. XII. In the Blanch mine, further east it shows 3′ 8″ of dirty, pyritous coal, so that at no place in the basin is this coal desirable.

have been developed but in few places, owing largely to the lack of railroad facilities in all that belt of country between the Penna. R. R. and its new Black Lick branch west of Ebensburg.

Various test openings however have been made as well as an important boring near the heart of the basin at Vinco in Jackson twp. (see plate 272 page 1786), which shows the prevailing characteristics of the *Lower Productive group* in the lower end of the basin. Along the Cambria and Clearfield road, in the Carrolltown district, a number of mining operations have been recently inaugurated along the waters of Chest creek, on the east side of the Laurel Hill axis.

The *Freeport group* and the *Kittanning upper ed C'* are opened in a number of places in the vicinity of the new town of Patton (formerly Marks Mills), known as the *Dry Run mines.**

The *Freeport lower bed D+* is the mining bed *par excellence*, both here and on the opposite side of the Laurel Hill axis in the *Westover* (Third) *Basin* along the Susquehanna, Brubaker and Walnut runs. The roof is generally sandstone, which accounts for irregularity of bed section. The Ashcroft and Columbia mines however both show 2′ of slate top beneath the sandstone ; coal, mining bench 3′ 6″—4′ 0″, beneath which there is slate and bone from 0 up to 4″ or 6″ and then a foot of bottom coal. In the Moshannon mine



On Little Chest creek the Wigton mine also shows a sandstone roof; an upper coal bench of 2′ 10″ sometimes showing a thin band of slate 8″ from top, not persistent; and a lower bench of 8″, separated by 1″ of slate from the upper bench. This section is quite different from the others; but there seems no reason to doubt the identity of the coal and all the structural evidence indicates its being bed D, though its section is entirely different from the *Lower Freeport coal* of the Houtzdale region in Clearfield and southern Cambria. Indeed its section more closely resembles the Kittaning lower bed B along Clearfield creek in this county; and along the Penna. R. R., South Fork and at Scalp Level; but bed B certainly exists lower in the measures on Chest creek, and was being tested 135′ lower, reported to show two benches, the upper 2′ 0″ and the lower 1′ 2″, parted by 0′ 6″ of fire clay, with the upper bench thickening on development.*

Towards Johnstown, along Laurel run, several beds of coal have been opened above water level near the old Cambria furnace and beds C′ and D were drifted in upon from the outcrop, the former about 3′ thick and the latter about 4′ thick, overlying its cement rock 8′ thick.

Along Salt Lick the *Mauch Chunk red shale No. XI* and *Conglomerate No. XII* outcrop in the valley up to the Forks in Jackson twp. The Lower Kittanning bed B has been opened on the Leidy branch, showing 3′ 4″ to 4′ thick, with good roof and floor and without visible bone, though the coal contains a somewhat higher percentage of sulphur than it shows to the east of the Viaduct axis† in the mines along the Penna. R. R. in the First basin.

Above the forks two higher coals outcrop on the *Page tract*, the lower corresponding with the Upper Kittan-

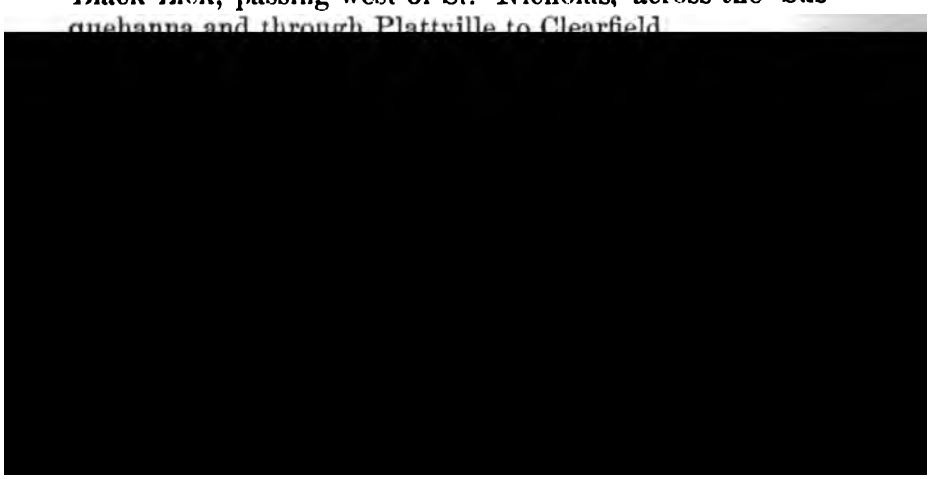
* The lower beds of the series are brought to daylight for a short distance on Chest creek north-east of Boniface by the effect of the Laurel Hill axis; but all the coals of the Lower Productive measures, in both the Second and Third basins, seem to become thin and treacherous here in north Cambria Co. To the south-west of Patton the coals sink beneath water level; but several borings have demonstrated their integrity there.

† At the Schafer bank, on the crown of this axis east of Mineral Point, the same bed shows 3′ 10″ thick, without parting.

ning coal or Cement seam, and about 2′ thick; and the upper, 35′ higher, and from 2′ 8″ to 3′ 2″ thick, with the Lower Freeport bed D. The *Funk bank* is opened on a third coal, 2′ 8″ thick with 2″ of bony coal on top and about 100′ above the Cement seam. It may be correlated with the Upper Freeport or Lemon seam bed E.

At the headwaters of Laurel run, about a mile south of the turnpike, the *Rose bank* is generally regarded as bed B, having a ferruginous shale roof and a somewhat irregular bed section. In places the seam runs up to 4′ 5″ with scarcely any parting; but frequently the top member is squeezed, leaving the coal 3′ 3″ to 3′ 10″ thick. The *Deshong bank*, north of the pike on the waters of Hinckston run, is also on the eastern side of the Laurel Hill axis. Although its identity is uncertain at present as the Rose coal, it is commonly regarded as bed B, showing a triple section with slate roof as follows: Top bench 3′ 8″; slate 0′ 3″; coal, middle bench, bony, 0′ 3″; slate 0′ 3″; coal, lower bench 2′ 1″.

The *Third or Westover basin* is but partially represented in Cambria Co., inasmuch as the Laurel Hill axis only enters from Indiana Co. just at the Penna. R. R., west of Johnstown, passing near Carrolltown and St. Boniface and west of St. Lawrence into Clearfield. The Westover basin line enters the county along the north fork of Black Lick, passing west of St. Nicholas, across the Susquehanna and through Plattville to Clearfield.



The *Black Lick region*, as already explained, is only just being developed, and there is still some obscurity regarding the identification of the coals there exposed, with the present evidence indicating the principal "*Black Lick Seam*" to be the *Kittanning lower* (Miller) *bed B.* In the two more northern districts, the *Freeport lower* (Moshannon) *bed D* is undoubtedly the chief source of a fuel supply. The top bed of the series here (Bed E?) shows about 4′ thick around the Big Bend of Black Lick, thinning westward to about 3′ along the Indiana Co. line. Bed D seems to be poorly represented; but 120′ below the top bed there occurs a coal (C′?) in places 3′ 6″ thick, but not very persistent; about 60′ lower comes the "*Black Lick Seam,*" the most important bed of the section, and from 100′ to 110′ lower bed A, which frequently shows as high as 6′, but always irregular and impure and filled with rash. In the lower part of the section (15′ and 40′ beneath the Black Lick seam) there are sporadic beds 2′ 10″ and 3′ 0″ thick, from which it may be judged how unusual the section is here.

The *Black Lick seam* (bed B?) is however everywhere an attractive and thick bed, with an unusually regular section, overlaid by slate and always of good character. Its average section, as determined from 27 openings examined, shows an upper bench of 3′ 10″ of clean coal, with extremes of 3′ 1″ and 4′ 3″; of these sections 21 show a thickness of 3′ 10″ and over and only one of the remaining six gave less than 3′ 4″. The middle bench averages 4″, with extremes of 1″ and 9″, 21 sections giving 4″ and over. The lower bench averages 1′ 1″, with extremes of 6½″ and 2′ 1″, in 21 sections, 11 showing over 1′ 11″ and 10 over 6″. The two slate partings enclosing the middle bench are from 3″ to 5″ thick. The main bench is always a good coal, and through much of the field the middle bench is also good; the lower bench is always impure, high in both sulphur and ash. The upper bench yields a coal with 70% to 74% fixed carbon, about 20% volatile matter, .8% to 1% sulphur and 6% ash.

This Black Lick seam remains above water level from near the forks to the east side of the Laurel Hill axis, extending also for a couple of miles up Coal Pit run and up the branch streams heading in Laurel Hill, but always with the same excellent section. The upper bench varies from 3′ 8″ to 4′ 0″ and the middle bench holds about 6″; but the parting slates are somewhat thinner, so that frequently the upper and lower benches can be mined together, especially in entry work.

In the *Susquehanna River district*, only 15 miles north in the same basin, totally different conditions exist (See vertical sections plates 418 and 419.) The *Freeport upper bed E* has only been noted at the Cymbria mine on Walnut run, but not elsewhere in this district, the bed at Barnsboro being replaced entirely by fire clay. The *Freeport lower bed D* occurs about 40′ lower and is worked at the Cymbria, Delta and Knight & Co mines on Walnut run, with the same average section as follows: bone coal top 0″ to 2″; coal 3′ 6″ to 4′ 0″; slate 0½″ to 1″ and coal 0′ 4″ to 0′ 6″.

On the Susquehanna it is mined at Lancashire Nos. 3 and 4 mines and Sterling No. 11, showing bone coal top 0′ 1″ to 0′ 2″; coal 3′ 6″ to 3′ 8″; slate 0′ 1″; bottom coal 1′ 0″. Also at the Spangler, Lancashire No. 5 and Sterling No. 13. The Kittanning upper and middle seams are both under 2′ thick, and the Kittanning lower bed B is oper-

reported 30′ lower in the measures, at Sterling mines Nos. 8 and 9; Oak Ridge and Hastings collieries, with 0′ 2″—0′ 4″ of top bone; coal 3′ 6″; slate 0½″ to 2½″; coal 0′ 8″ to 0′ 10″. Bed C′, 33′ lower and underlaid by cement rock, has been mined at Sterling No. 6 and Benton mines, with top bench 4′ 4″; slate 0′ 2″ and coal 1′ 2″; but the product was impure as compared to that won from Bed D. Bed B was mined at the Sterling No. 10 and Benton, with the same section as at the Eleanora mine, the bottom coal sometimes reaching 2′ 4″ in thickness. For other details of this district, see vertical section, plate 415.

*No. XIII in Somerset County.**

This county has four well defined coal basins. Two of them, the *Salisbury–Berlin basin* and the *Wellersburg basin* (the later wholly east of the Allegheny Mts.) lie to the east of the Negro Mountain anticlinal, which subdivides the First basin of Centre, Clearfield and Cambria Cos. into two divisions in Somerset.

The Viaduct anticlinal separates the true First and Second basins, curving southwards after passing the Casselman river and further offset eastward approaching the Maryland line. Thus we have four distinct and separate coal basins between the Bedford and Fayette–Westmoreland Co. lines, as follows:

1. *Wellerburg basin.* 2 *Salisbury–Berlin basin.* 3. *First, Somerset or Wilmore basin.* 4. *Second or Johnstown basin.* The first two contain remnants of the *Upper Productive Coal Measures.*†

The *Wellersburg* or *Southampton coal basin* is three miles wide at the Maryland line (see Ann. Rep. 1885 page

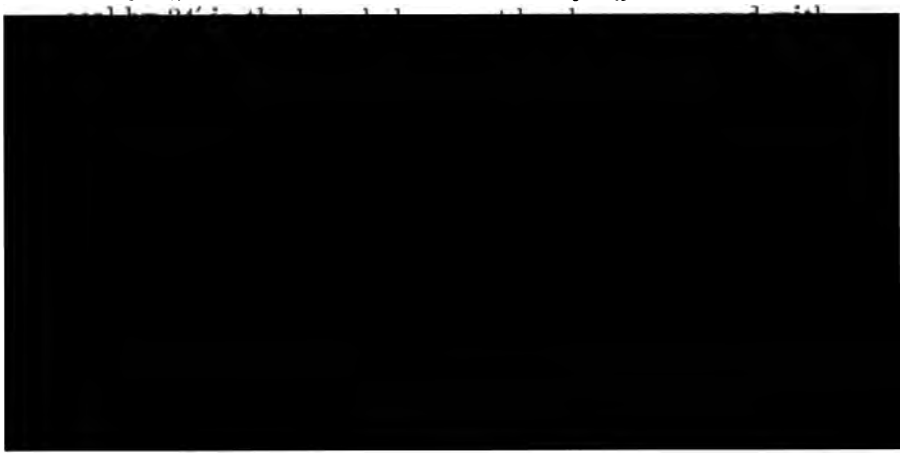
* Report H3, Franklin Platt 1876. This report was one of the earliest issued by the Survey and in common with Cambria Co. which it adjoins on the south, its important deposits of coal are now being so largely developed that only the cessation of field work in 1890 has prevented a re-survey and a more complete description of its varied geology and structure.

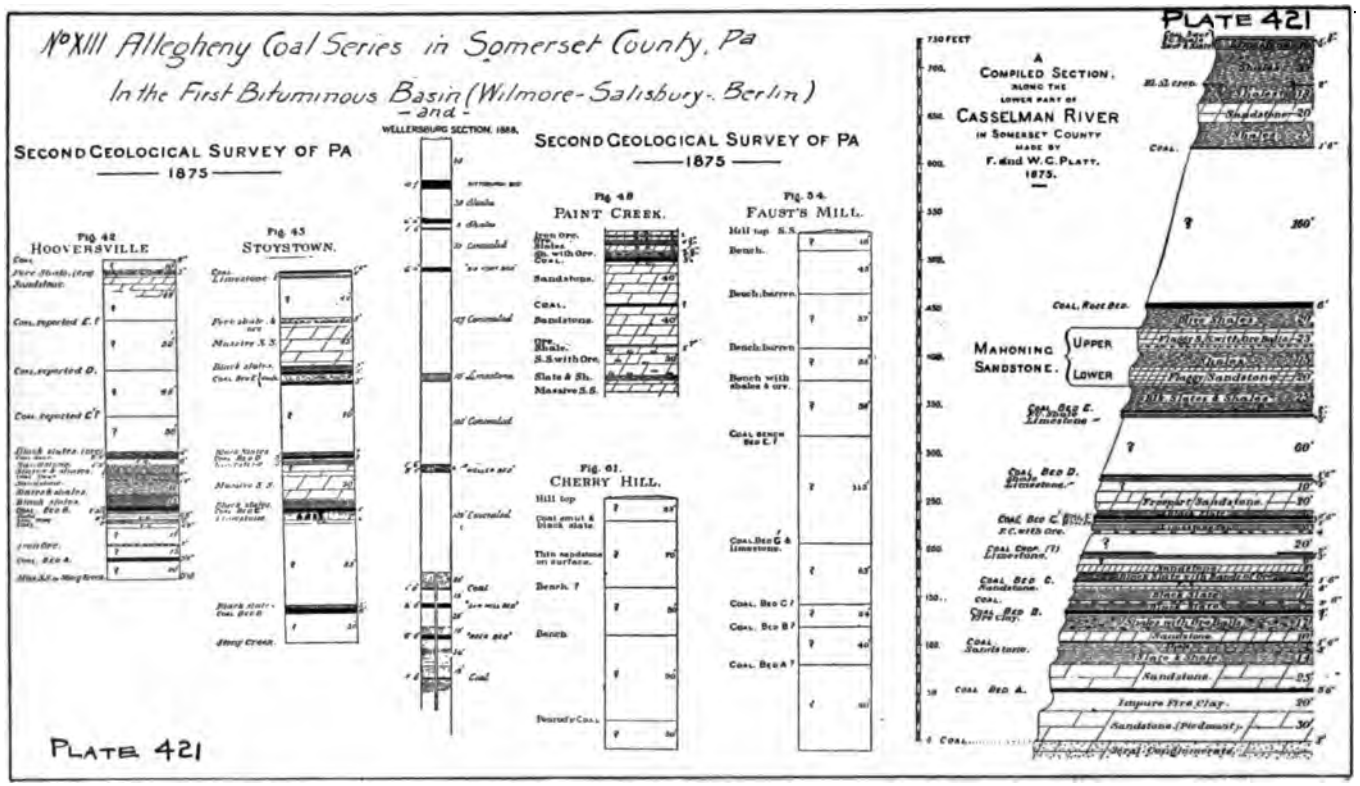
† The only evidence of this group of rocks in the State east of the Laurel Hill axis, unless we except the small patch of the Pittsburg bed in the Broad Top field and its possible representation in some of the Anthracite basins.

228) measured from the conglomerate crest of the Great Savage to the conglomerate crest of Little Savage Mts. As a coal basin its value is so overshadowed by the Georges Creek country in Maryland that the mining of its coal beds will not be actively carried on until the exhaustion of the Maryland field. The great *Pittsburgh bed* of Georges Creek spoons out before it reaches the State Line although it is again caught in the tops of the highest hills north of Wellersburg, where it occupies a few hundred acres.

The *Allegheny Coal Series* (under the Mahoning sandstone 60′ thick) shows three main coal beds* in a vertical interval of about 250′ down to the *Piedmont* or *Homewood sandstone*, top member of No. XII. These beds are exposed in the *Gladen's Run coal field.* (Plate 421).

The "Saw Mill" coal is the top bed of the series and has been doubtfully correlated with the Upper Freeport coal E, solely on account of the 5′ limestone bed underlying it and by its estimated interval of 740′ below the Pittsburg bed.† It shows two benches, the upper varying from 2′ to 3′; the lower from 1′ to 1½′, parted by a slate from 6″ to 1′ thick. The "Rock Seam" coal lies 50′ lower, and where drilled through by an experimental oil well, it is reported to be 4′ thick; but where it crops on the surface it is impossible to verify this measurement. A black slate formation 15′ thick, overlying a coal bed 1′ thick and underlying the Rock Seam




No XIII Allegheny Coal Series in Somerset County, Pa
In the First Bituminous Basin (Wilmore-Salisbury-Berlin)
-and-
SECOND GEOLOGICAL SURVEY OF PA
1875
Fig. 42
HOOVERSVILLE
Fig. 43
STOYSTOWN.
WELLERSBURG SECTION. 1888.
SECOND GEOLOGICAL SURVEY OF PA
1875
Fig. 48
PAINT CREEK.
Fig. 54.
FAUST'S MILL.
Fig. 61.
CHERRY HILL.
PLATE 421
A
COMPILED SECTION,
ALONG THE
LOWER PART OF
CASSELMAN RIVER
IN SOMERSET COUNTY
MADE BY
F. and W. C. PLATT.
1875.
MAHONING SANDSTONE.
UPPER
LOWER
PLATE 421



aggregating nearly 50′ of sand rock beneath this coal, separated by shales and clay, in an interval of 90′, and this sandstone formation has been compared to the Clarion sandstone of western Pennsylvania.

In the matter of fire clay this Wellersburg region is quite prolific, containing the celebrated Mt. Savage fire clay bed, just above the conglomerate, which outcrops on both sides of the basin its whole length in Somerset Co., and has been long and successfully mined on Will's creek. In the *North Savage Fire Brick Co.'s* mine, at Williams station, the thickness of the clay varies from 10′ to 12′, a large portion of it being hard or flint clay. The two kinds of clay do not hold any regular relationship, the hard clay being sometimes on top and sometimes below the plastic clay, but more often found below; and the relative proportion of hard and soft clay varies to the same extent. The hard clay is the variety most sought after; but it is mixed in various proportions with the soft clay according to the purposes for which the fire brick is to be used; the hard clay making a more porous brick, and the soft clay one more dense. The *Savage Fire Brick Co.* worked on the northeast side of Will's creek, their clay varying from 4′ 6″ to 6′ thick, although in places squeezed out entirely and elsewhere swelled to 25′. It shows about the same average thickness and character as in the first mine described, whose works adjoin.

These remarks would apply in great measure to works at *Keystone* and *Ellerslide.**

* The whole district, with details of mining and manufacture, is fully described in the *Annual Report* for 1885, pages 239 to 249. The fire clay bed is exposed along the face of the mountains about 300′ above the bed of Wills creek at Williams station.

Section of clay bed: North Savage Fire Brick Co. mine: pit mouth.

Coal (reported),	4′
Concealed,	19′
Sandstone, fine, light colored, massive,	10′
Coal,	0′ – 1′
Fire clay,	12′
Shale,	5′
Sandstone current bedded.	

In a second opening the outcrop thickness of clay is 4′ 6″; at 350′ inside mine 6′; at 550′ only 2″; at 650′ clay disappears, together with the coal above;

In the *Salisbury district*, between the B. & O. R. R. and the Maryland State line, the coals of the *Lower Productive group* have quite an extensive outcrop area on the flanks of the Allegheny and Negro mountains; but in the presence of the large *Pittsburgh bed* in the center of the basin, these underlying and thinner coal beds have never been developed to any extent and their identity is yet somewhat obscure. The group is about 300′ thick.

In the *Berlin–Salisbury basin*, between Shanksville and the Castleman river, these measures* are confined to those portions of the district lying close to the mountain ridges on the east and west. It is doubtful if there are any coal beds in this basin north of Shade creek; but between the two forks of that stream the entire group is caught in a small area along the trough of the basin, although none of these coals have ever been opened for inspection. Excepting in the neighborhood of Garret, on the B. & O. R. R., along the eastern base of Negro mountain, few developments have been made on the coal beds of this group.

Along the western base of the Allegheny mountain they have been partially developed at Engel's mill, nearly due east of Berlin, and at Hays' mills, about 1⅛ miles east-northeast of Berkley's mills. The *Altfather* mines show two coal beds, barometrically 40′ apart, but at sufficient

100′ further it comes in again and at 1200′ it is 25′ thick. The proportion of hard and soft clay is about the same in each opening. Iron ore balls are frequently met with, in all parts of the bed.

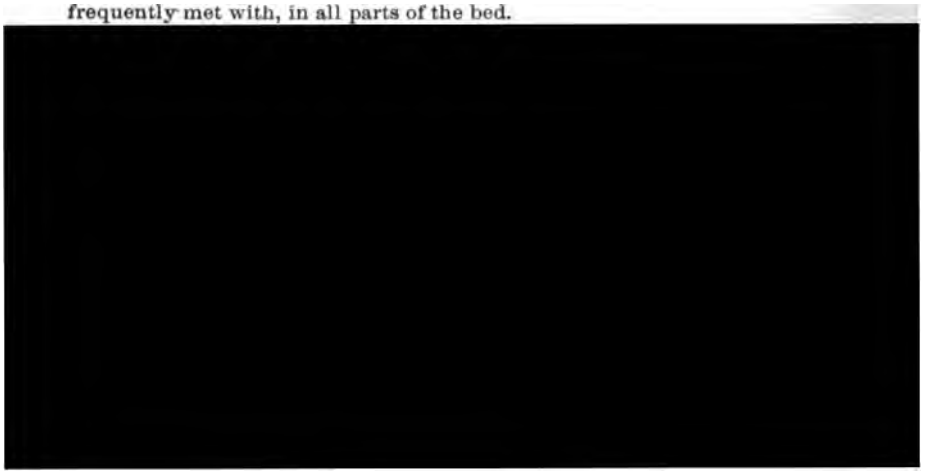
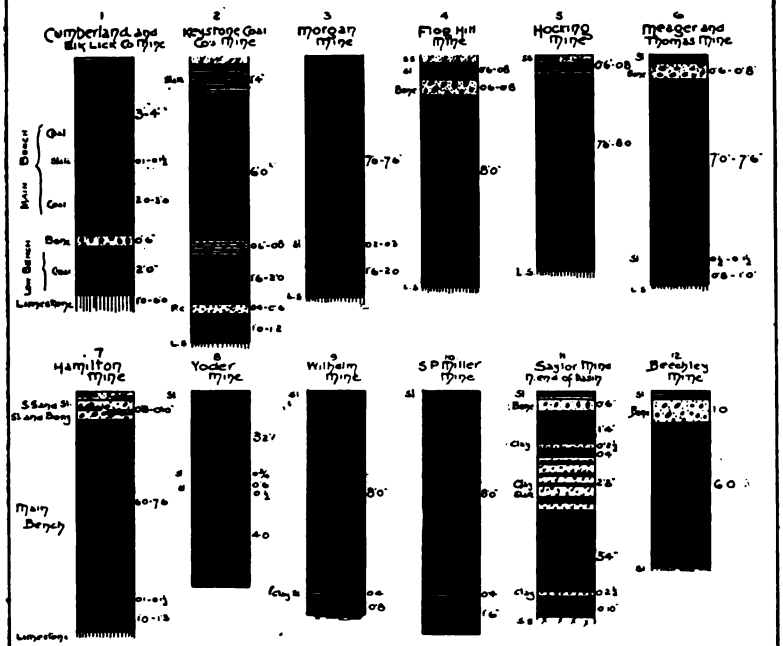


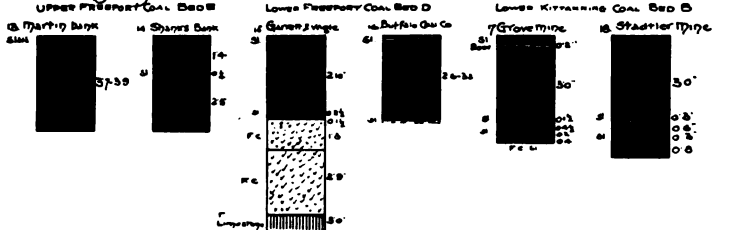
PLATE 422

Coal-Bed Sections in the Salisbury-Berlin Basin

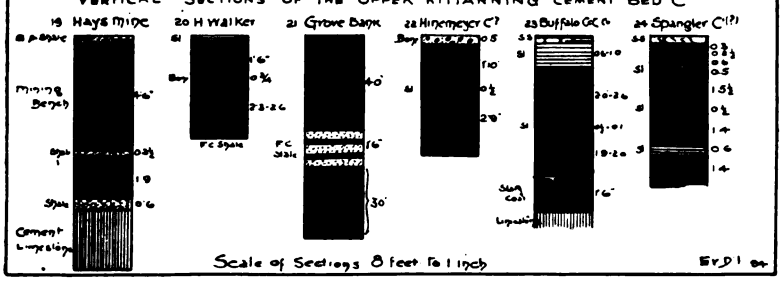
No XV Pittsburgh Coal. Mon River Series Somerset Co



No XIII Allegheny Coal Series in Berlin Division First Basin Somerset Co.

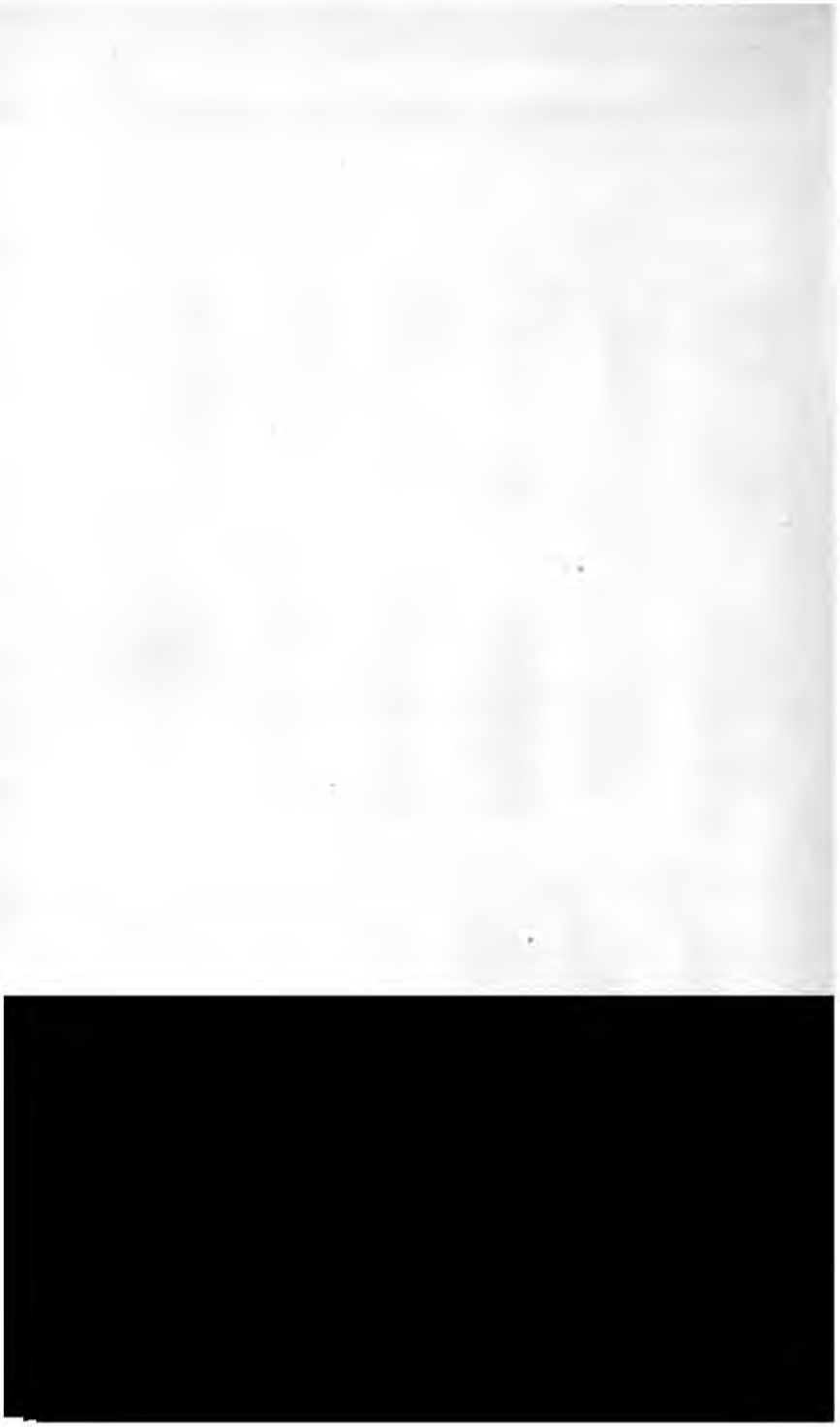


Vertical Sections of the Upper Kittanning "Cement" Bed C



Scale of Sections 8 feet to 1 inch

Erd 1 94



distance from each other to make it possible that they are the same.*

There is a great lack of limestone in this vicinity, and though it was believed that the coal beds developed are near the base of the group, this fact could not be fully established.

Hays' mills, 5½ miles to the southwest on a branch of Blue Lick creek, shows two coal beds, separated by about 70′ of measures, which are supposed to represent the two *Freeport coals*, from the fact that a massive (Mahoning) sandstone covers the surface just above the outcrop of the higher coal and a bed of limestone, 3′ thick, occurs 18″ below the lower coal. The beds are not opened and very little is known of their possible thickness.†

The chief "key rock" in this and the adjoining *Wilmore basin* along the waters of Stony creek is the *Johnstown cement*, underlying the *Kittanning upper coal C'*, a band of rough dark grey limestone 6′ to 8′ thick, nearly always present and opened in a hundred places by the farmers to obtain a supply of lime for fertilizing purposes.

The *Upper Kittanning coal* or *Cement bed C'* is nearly everywhere 3′ and upwards in thickness, in some places 7′ to 8′ thick, although in that event carrying slate partings which cut down the commercial part of the bed to 4′ 6″ or 5′, generally thicker in the Berlin basin.

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*The so-called "lower bed" measures 8′ 2″, with four slate partings and five coal benches, the two lower benches being bony. The other mine on same farm shows a bed 4′ 11″ in three benches, 1′ 3″, 0′ 9″ and 2′ 9″, separated by two bands of slate each 1″, although beneath the lower coal there is reported a slate band of 8″ and an additional coal bench of 6″, the whole underlaid by a cement rock. This bed would therefore show a thickness of 6′ 1″, of which 10″ are slate, whereas the first bed is 8′ 2″ with 13″ of slate. This latter "upper bed" was again opened near its eastern outcrop on the old *Schrack farm* from which the largest local output in the vicinity has been obtained. The bed exposed is 4′ 2½″ thick with coal benches of 11″, 8″ and 2′ 6″, the latter having 2″ of bony coal on top and the slate partings between the other benches measuring each 1″.

†A recent personal examination of the territory between Buckstown and the line of the South Penn R. R. elicited beyond question the fact that several of the *Lower Productive coal beds* are present in workable condition in this part of the region, although largely concealed by the *Barren Measure rocks*, except on the margins of the field.

The *Upper Freeport coal E* occurs from 80′ to 100′ higher in the hills and will average about 3′ 6″ of coal, the bed varying from 3′ to 3′ 10″, though usually carrying a thin slate parting near the floor when thickest. It is frequently more accessible to the farmers and its coal in both basins is always attractive, having a particularly bright clean appearance, soft columnar structure and showing a decided tendency to coke when burned; but while it is free from serious slate partings it often carries thin plates of iron pyrites, difficult to detect and to separate in mining, but which show the coal to be rather higher in sulphur than the best steam coal going to market from the Allegheny Mountain field.

The *Lower Freeport coal bed D* occurs nearly midway between bed E and the Cement seam C′, and is likewise underlaid by a limestone, much thinner and purer than the cement band and separated from its coal by 8′ or 10′ of fire clay and slate. This coal, so important in the *Moshannon, Punxsutawney* and *Carrolltown districts* further north, has no commercial value in this district, being rarely over 30″ thick; but it is very useful in identifying the two other workable coals, above and below it. The *Middle Kittanning coal C* is likewise an unimportant bed, underlying the Cement seam by 35′ or 40′, usually dirty and rarely opened at all. The *Lower Kittanning coal B* or *Miller seam* occurs 30′ to 35′ still lower and is the third important bed of this and other basins in Somerset Co.*

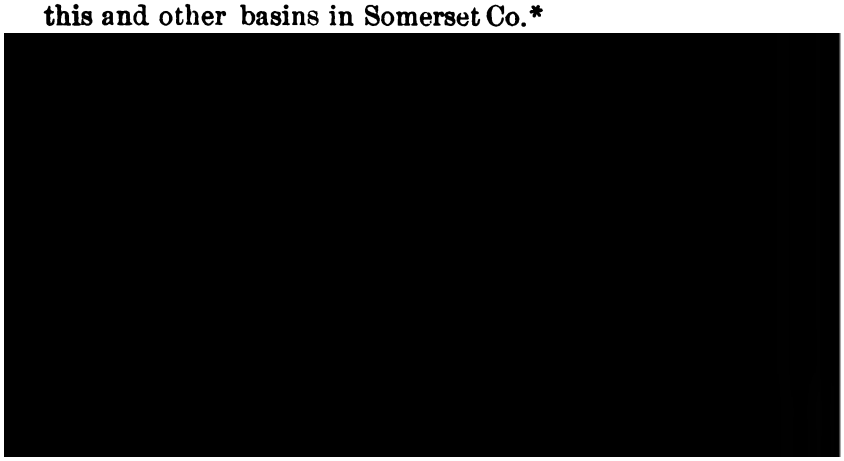
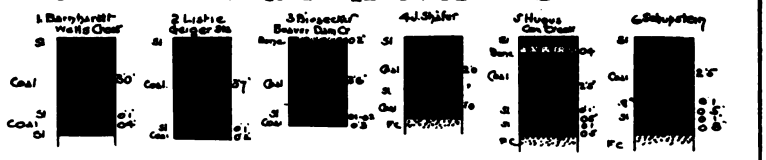


PLATE 42B.

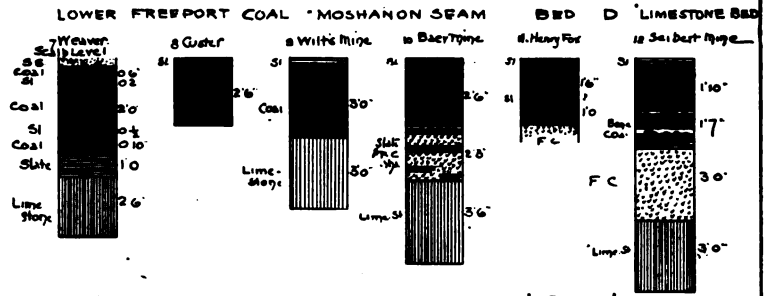
No XIII. Allegheny Coal Series in Somerset County Pa

Coal Bed Sections in First (Wilmore) Coal Basin

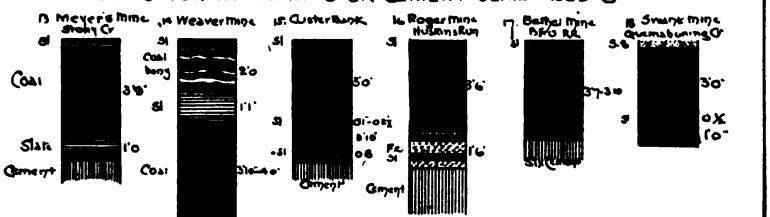
UPPER FREEPORT COAL "LEMON SEAM" BED E



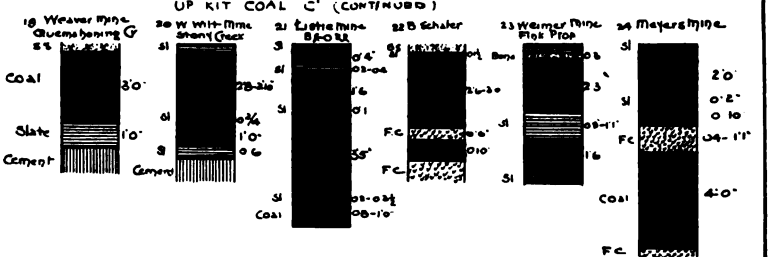
LOWER FREEPORT COAL "MOSHANON SEAM" BED D "LIMESTONE BED"



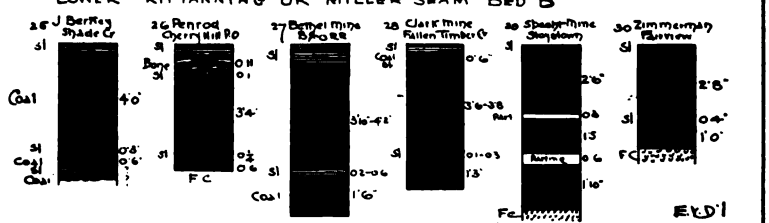
THE UPPER KITTANNING OR CEMENT SEAM" BED C'

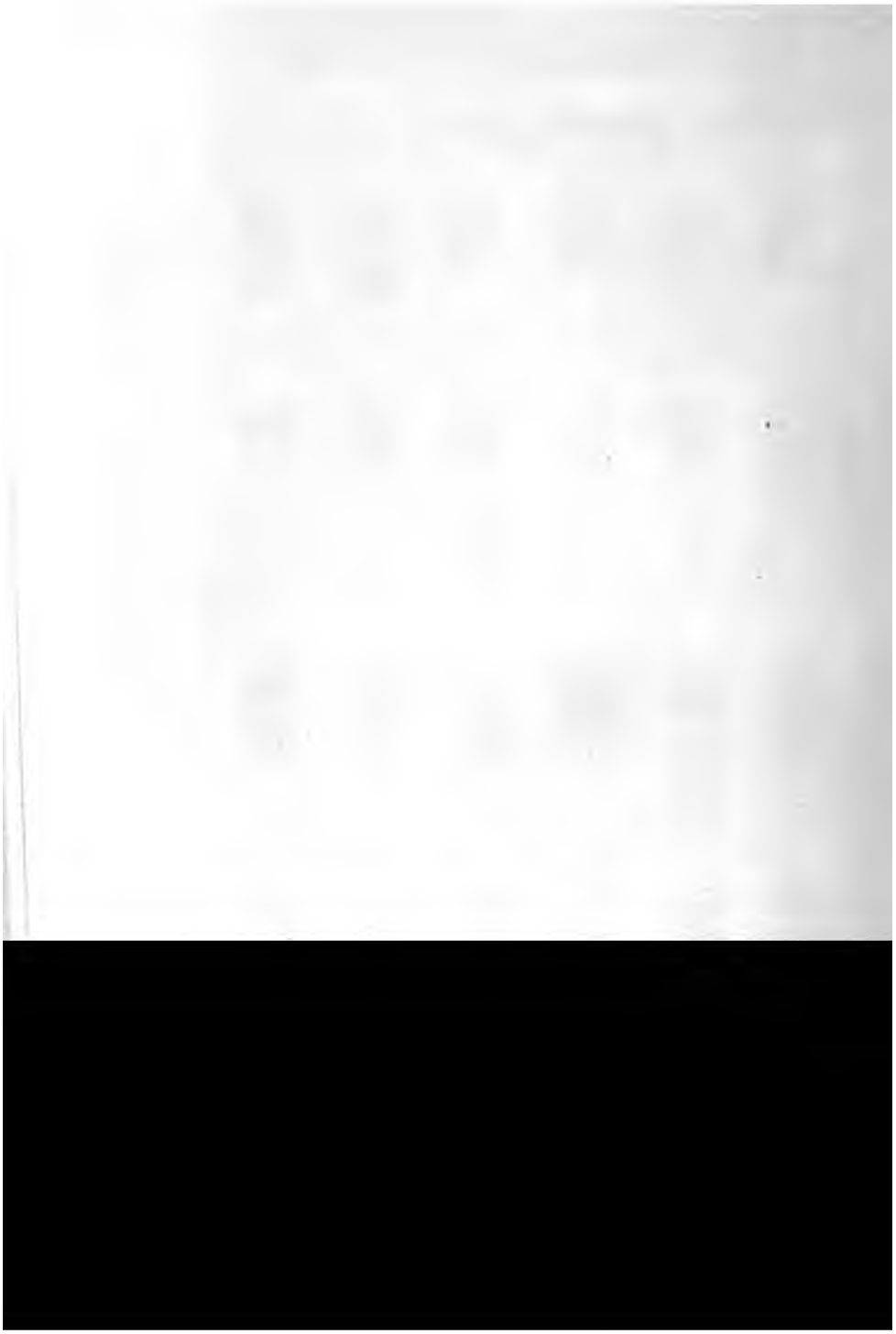


UP KIT COAL C' (CONTINUED)



LOWER KITTANNING OR MILLER SEAM BED B'





In the *Somerset-Wilmore* (First) *Basin* the *Barren Measures* and the *Lower Productive coal group** comprise the surface rocks, the former more abundantly north of Somerset and the latter occupying three-fourths., of the area south of the county seat. The cause for this condition of affairs is directly due to the stratigraphy of the district.†

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entirely to upper bench, with sulphur 1.112 and ash 7.625%. No limestone has been found beneath it and many regard it as bed B.

The *Hinemeyer bank* rather resembles Cement seam C', opened on the opposite side of the axis, 100 lower in actual elevation than the Grove bank but underlaid by the Cement limestone. Mining bench is 4 7½" with a hard slate 0½" rib 1' 10" from top and above carries 5" of bone coal and 6" of slaty coal. Though its section is attractive the coal carries minute particles of slate interleaved between divisions of columnar coal; hence sulphur and ash are both prominent.

The *Lambert opening*, 1¼ miles nearly due south is evidently bed E, developed for local use: Berlin basin. Full section 3' 9" thick; but only top 3' is worked and carries a persistent seam of iron pyrites about 2' 6" from top. Below this upper coal bench there is a slate parting 2" to 3" thick and then 6' to 8" of hard bony coal.

The *Cover mine*, on top of Negro Mt. several miles west of Berlin is also probably on this bed, the seam showing 3' 5" thick with several small partings. This is the *Hugus bed* near Somerset.

Bed C', with its cement limestone, shows near Garrett yielding 6½' of indifferent coal, divided into two benches by a persistent band of fire clay slate, which in the *Somerset-Wilmore basin*, south of Hooversville, becomes its most prominent and characteristic feature.

The *Hay's mine* shows this bed with upper bench 4' 6" and a lower bench 1' 9" divided by 3½" of shale and underlaid by several feet of the Johnstown cement. Coal D shows a thin section where track crosses Buffalo creek. Bed E is small and unimportant here.

The *Hiram Walker mine*, where bed C' crosses Buffalo creek, shows upper bench 4' thick, carrying a band of bony coal ¾" thick, 1' 6" from top. The coal mines out in blocks and would bear transportation well; but it carries both sulphur and earthy matter in abundance. At the *Wigle mine* 6' of coal underlaid by limestone; but coal carried sulphur 2.587% and ash 10.135%. The coal is tender and carries slate.

The *Lower Freeport D* (the Middle Freeport D' of Report H 3) is a thinner but better coal in this vicinity, being quite extensively developed by the *Garret Coal Co.* It averages from 32" to 36" of coal in one solid bench. A small 2½" slate separates this bench from a thin 1½" coal at the bottom, under which there is 4' of fire clay and then 3' of good limestone.

*Various vertical sections of the *Allegheny Coal Series* and their coal beds are shown on plates 421, 422 and 423; and two special plates have been prepared of the *Scalp Level Mining District* to show the characteristics of the two principal beds B and C'. See plates 424 and 425.

†Along the Cambria Co. line the Viaduct and Negro Mt. anticlinals, bounding the coal basin, are nine miles apart; along the Maryland line the

The Lower Productive group has a vast expanse above and below water, and they may be said to stretch uninterruptedly from the Cambria Co. line to the Castleman river, arching over the anticlinals which confine the basin and spreading out into the troughs east and west. South of the river the uplift of the whole basin has exposed it to much sharper denudation and the coal rocks have been swept away from nearly all portions of this area. The *Productive Coal Measures* actually cross the river but they thin out rapidly to the south-west and ultimately disappear entirely, leaving this section almost destitute of fuel. Here the *Carboniferous limestone in No. XI* is quarried in considerable quantities. The coals of this basin are mainly thin, especially south of Hooversville on Stony creek; but to the north of that point to and into Cambria Co., both the *Lower* and *Upper Kittanniug beds* are well developed, the former especially showing a seam of great regularity and purity, with unexcelled opportunities for development.

Between Paint and Shade creeks at the northern end of the basin in Somerset Co, there is a large and compact area of the *Lower Productive Coal Measures* extending from the B. & O. R. R. to Ashtola, where the lowest beds of the series crop out to day-light on the Negro Mt. anticlinal. Some of the highest hills contain patches of the overlying *Barren Measures*; but the economic wealth of this region is mainly dependent upon two beds of the Kittanning group—the *Cement seam C'* and *Miller seam B*.

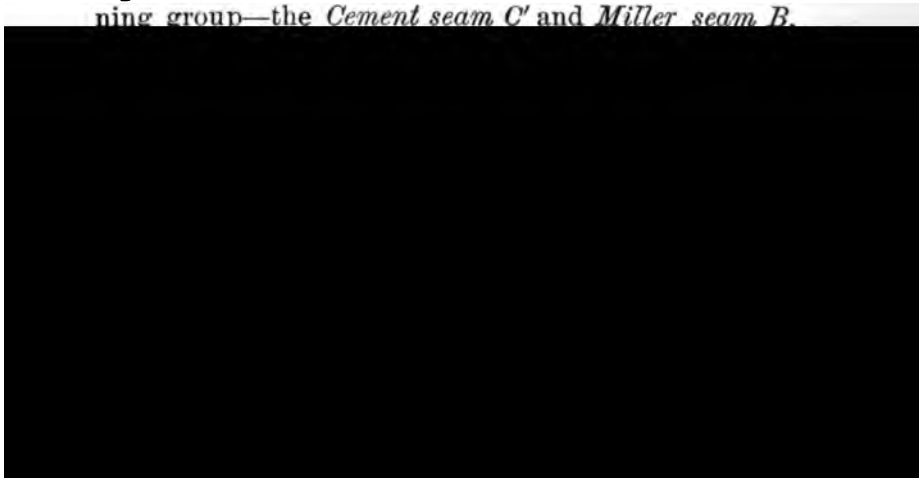


PLATE 42A.

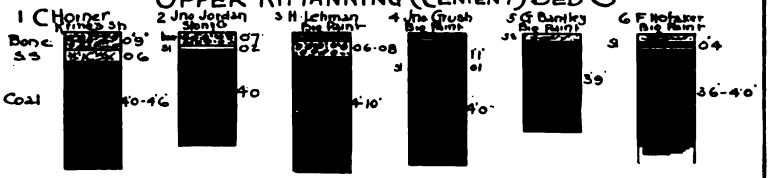
No XIII Allegheny Coal Series in Somerset Co

Coal-bed Sections in First (Wilmore) Basin

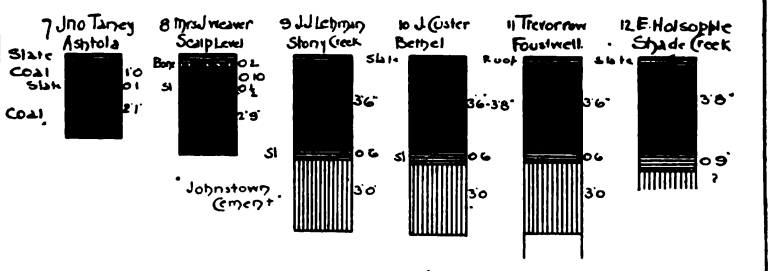
SCALP LEVEL MINING DISTRICT

along Big and Little Paint, Shade and Stony Creeks.

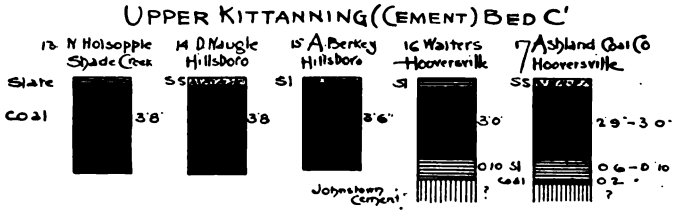
UPPER KITTANNING (CEMENT) BED C



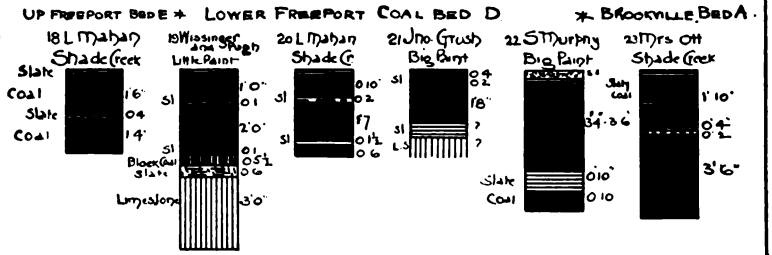
UPPER KITTANNING (CEMENT) BED C'



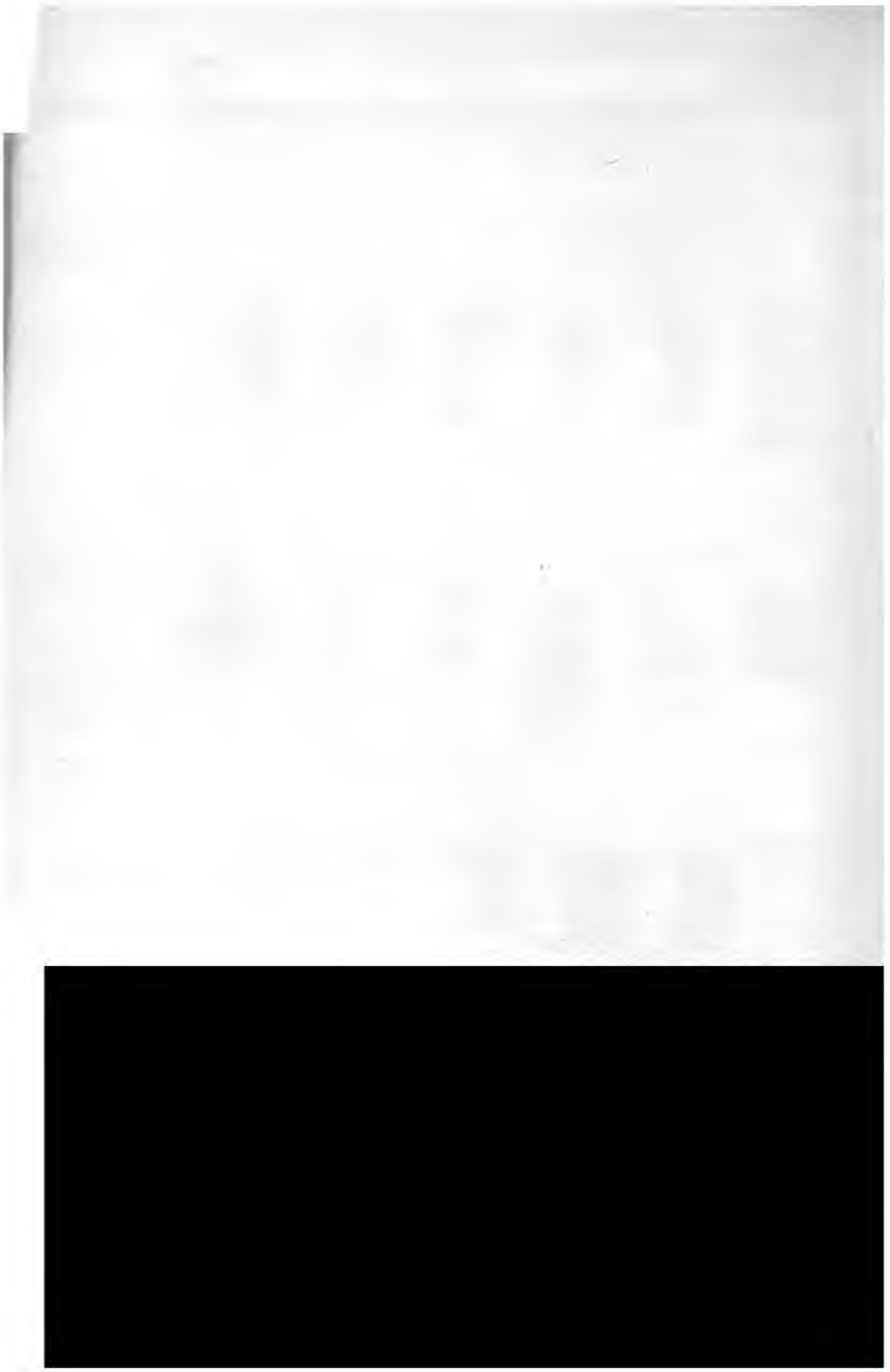
UPPER KITTANNING (CEMENT) BED C'



UP FREEPORT BED * LOWER FREEPORT COAL BED D * BROOKVILLE BED A.



E.K.B.I.



bed A is fully 250′ above creek level) towards the Negro Mountain axis, at first gently and then more rapidly; and the entire group *sinks south-westward* from Paint towards Shade creek, though pitching much more strongly from Paint north-east towards South Fork in Cambria Co. The entire group is about 225′ thick; 40′ to 45′ between E and D; 30′ between D and C′; 85′ between C′ and B and 64′ between B and A. At Hooversville these intervals average, 52′, 35′, 80′ to 85′ and 42′.

The *Freeport upper bed E* has very little commercial value, rarely over 3′ and usually parted near center by a band of slate.

The *Freeport lower bed D* has no greater value as a coal bed, varying from 2′ 2″ to 4′ 6″, and where thickest carrying 10″ of slate a foot above the floor; still it is frequently mined for calcining the limestone bed which underlies it in many places.

The *Kittanning upper bed C′* is also largely worked locally for this same purpose, the Johnstown Cement beneath it frequently showing 3′ of pure limestone on top, out of a total of 6′. The coal bed, out of 17 sections measured, averaged 3′ 8″, with sulphur 1.5% and ash 8%. As far south as Hooversville the coal usually occurs in one bench, strongly characterized by a laminated, block structure and rarely showing any bone on top. (See sections plate 424.)

The *Kittanning lower* (Miller) *bed B* shows just as pronounced characteristics, but strongly contrasting with those of bed C′. The 30 vertical sections on plate 425 were selected to best indicate the features of this bed. *Typically* it is a double bed as in Cambria and Clearfield Cos., with a thick upper mining bench of lustrous columnar pure coal, separated from a thinner impure lower bench by a thick bone and slate parting. This lower division is rarely exposed in the mines as its coal is too impure to work; but it runs from 6″ to 1′ 6″ with an average of 1′. The parting is from 5″ to 10″, and the upper bench usually carries from 2″ to 4″ of bone on top. Thirty-three sections of this mining bench gave an average of 3′ 10″ of merchantable coal, with extremes of 3′ 0″ and 5′ 2″, and an average of 60

analyses, from samples of three independent observers, showed sulphur .880% and ash 6.108%, closely resembling the chemical character of the Cumberland coal and but slightly inferior to the celebrated Pocahontas (Flat-Top) coal of West Virginia, of which 24 samples gave sulphur .744% and ash 5.544%. It might be remarked as a curious incident of the varying importance of individual coal beds that the *Kittanning lower bed B* shows a decided increase in sulphur and ash in approaching the Viaduct axis, to such an extent that in the *Second basin* it frequently carried 1½% sulphur and 8% to 10% ash, while the *Kittanning upper bed C'*, everywhere of inferior chemical character and bed section in this part of the *First basin** shows

*In the *First basin* south of Hooversville to beyond Somerset, the *Kittanning upper C'* improves in chemical character though it gradually becomes parted by a band of slate, while the *Kittanning lower B* is largely under water level, except on eastern side of the basin towards Negro Mt.

Along Stony creek bed B has been first opened at Kring's station on the B. & O. R. R., but on the west crown of the Viaduct axis. This fact has led to great irregularity of bed section in the *Ingleside mine*, where the coal varies from 2' to 4', frequently squeezed (and then rendered very impure by increased percentage of iron pyrites) and with severe dips. It is 220' above the creek. At the *Bethel mine* further southeast, between Faustwell station and Bethel, the same coal 25' above track level, shows a main bench 3' 10" to 4' 2"; slate 2" to 6" and a lower bench of hard coal, not mined, 1' 6". The mine is subject to the same rolls as at Krings which renders mining expensive at times.

The *Cement seam C'* here carries a sandy roof and shows 3' 7" to 3' 10" of of good clean coal above a slate and limestone (cement) floor Same bed and cement shows at Meyers mine above mouth of Shade creek but one

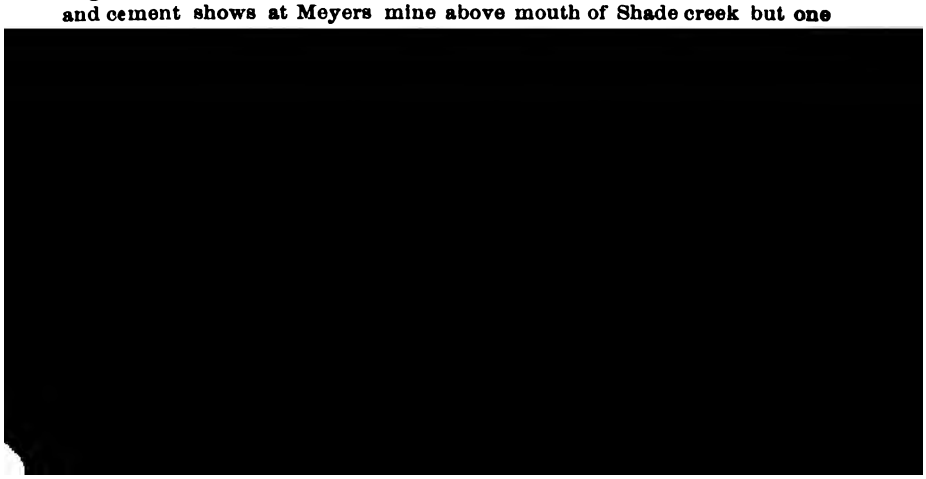
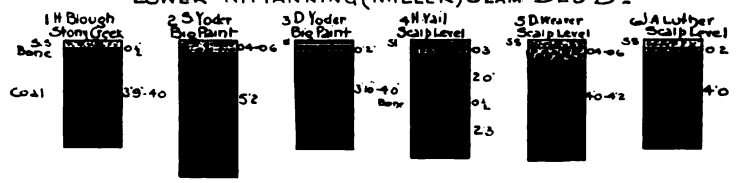


Plate. 425.

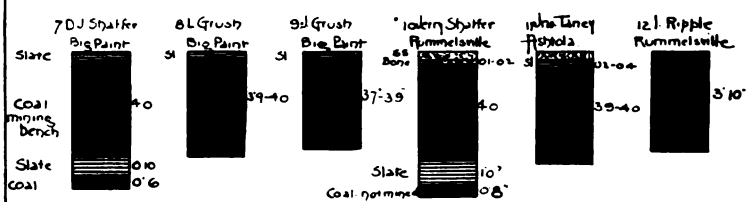
No XIII Allegheny Coal Series in Somerset Co Pa

Coal-bed Sections in the First (Wilmore) Basin

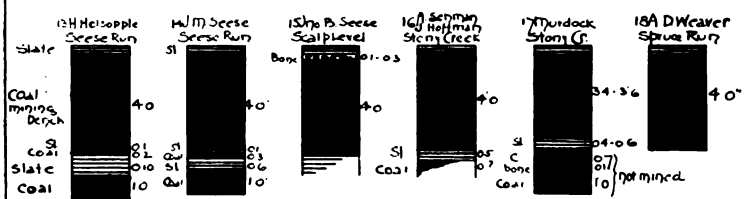
Lower Kittanning (Miller) Seam Bed B.



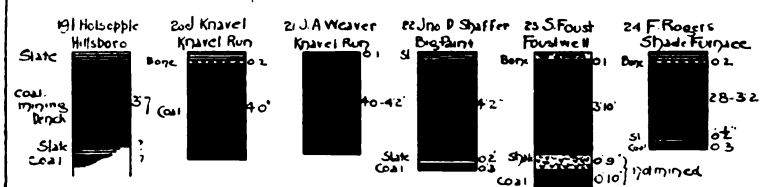
Scalp Level



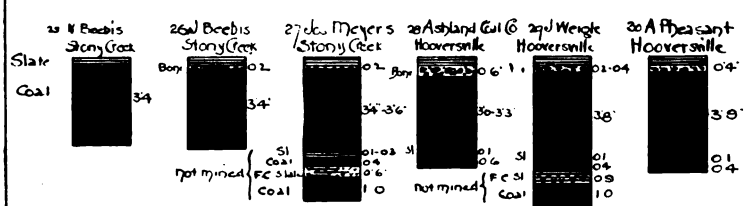
Mining District



Big and Little Paint



and Stony Creeks



R.K.D'J.



and bed B is also opened 90′ lower, fully 5′ thick, but parted in two places by two bands of slate.

At Stoystown both the Freeport coals outcrop along Stony creek and for some distance up Beaver Dam run. The Upper Kittanning C′ bed is also above water level along this creek as far south as Listie station; but the Lower Kittanning bed B hugs the creek closely and can be opened for drift mining with difficulty, except to the southeast, where the Negro Mountain anticlinal hoists it into the hills along Stony creek. At the Specht mine, below Sprucetown, this bed shows three benches of coal, separated by thin bands of hard fire-clay shale 3″ and 6″ thick, the coal benches being 2′ 4″, 1′ 5″ and 1′ 10″ thick, making in all 6′ 6″. Upper bench yields fairly clean coal of columnar structure; crumbles fine in mining and possesses a fine lustre, the central bench a harder and decidedly inferior quality of coal. Rolls and irregularities in the fire-clay shale underlying this bench cause it to vary in thickness from a few inches to 1½′. The lowest bench is very impure and almost worthless so that the entire bed cannot be relied upon to yield over 4′ of mining coal. The Cement seam C′ is opened on opposite side of Stony creek, some distance from Specht's and much lower in the hills. Top bench 2′ 8″ to 2′ 10″; parting ¾″ and bottom coal 1′ 0″, separated by 6″ of slate from Johnstown cement bed 7′ thick. The upper bench is compact and shows horizontal cleavage; carries iron pyrites often in large balls. The bottom bench is slaty, and sample of whole bed would show over 1½% of sulphur and over 11½% of ash. Bed D has been opened 50′ higher and 3′ thick, underlaid by an equal thickness of impure limestone. Bed E also outcrops still higher, and in vicinity of Stoystown, occasionally shows a double structure, two coal beds each 3′ thick separated by as much as 8′ of shale (see Stoystown vertical section plate 421).

Around Mostoller station several openings indicate that bed B exists above water level for at least half a mile up and down the railroad as well as for nearly two miles up Stony creek towards the Negro Mountain axis. This bed has been apparently faced recently on the creek immediately opposite Mostoller's saw mill. No good section could be obtained although showing about 5′ of soft coal with its lower portion streaked with slate. It takes water level about 200 yards up Wells creek.

Bed C′ is opened below public road leading to Stoystown at Custer bank; top bench 3′; slate 1″ to 2½″ and bottom coal 10″, separated from the cement limestone by 8″ of fire-clay slate. Coal attractive but bottom bench impure, yielding nearly 2% of sulphur and over 10½% of ash. Bed D is opened 35′ higher and about 30″ thick. Bed E is opened at Barnhart bank, in next ravine south; thin and dirty, only 2′ 10″ thick, with high percentage of both sulphur and ash.

All these coals dip westward from Wells creek into Wilmore basin, which closely follows line of Beaver Dam creek. Hence the Cement seam C′, opened on this creek by J. Kimmel, a short distance west of Wilt's mine, is 75′ lower in elevation, although still 25′ above water level in Beaver Dam. It is 3′ 4¾″ thick, with usual thin parting separating upper bench, 2′ 10″, from lower bench, 6″; upper bench is alone mined.

Tho *Listie Mining and Manufacturing Co.* is the only commercial development in this district, on the B & O. R. R. at Snyder's Station.

The Cement Seam C′ is their principal bed opened just east of railroad

station and about 2000′ feet from Wells creek. The coal has about 100′ of cover; but dipping northwestward it disappears before reaching Wells creek and at the station is perhaps 30′ beneath track. Two sections of this bed are given below, as perhaps this is the best point to see the character of the coal in this region; *No. 1*, a general section as given by the Superintendent; No. 2, my personal section at working face (see plate 423):

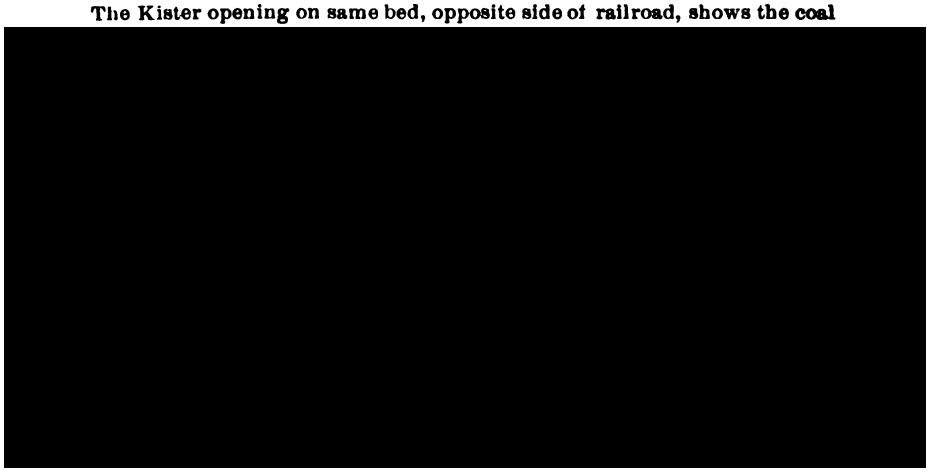
Vertical Sections of Bed C′ at Listie Mine.

No. 1.			*No. 2.*		
Slate roof.			Roof, not mined 0′ 8″		
Top coal 4″—8″ average 0′ 6″					
Slate,	0′ 2″—0′ 4″		*Coal*,	1′ 7″	
Coal,	1′ 6″	Mining	Slate,	0′ 2½″	4′6″
Slate,	0′ 1′	Section	*Coal*,	2′ 8½″	
Coal,	3′ 5′	5′ 0″	Slate,	Not mined in	
Slate,	0′ 2″—0 3½″		*Coal*,	rooms.	
Coal,	0′ 8″—1′ 0″				

Bed will yield 4½′ to 5′ of coal and two analyses, submitted by the company, show chemical quality far above its average in the county, as follows: F. C. 76.½%, V. M. 17½%, sulphur .63% and ash 4.51% to 4.85%. I should hardly anticipate that such a character of coal can be regularly shipped in large quantities without extreme care in mining and preparation; but the coal is undoubtedly in excellent condition here and its development must have a good effect upon the neighboring region, where it has a large area.

Upper Freeport coal E was opened by same company near Geiger Sta., where the coal is said to make a good coherent coke. It is certainly much softer than bed C′ with long columnar structure, friable and bright; but its bed section is thinner, and unless it is mined for coking, its development will naturally be retarded. It here shows top bench 3′ 7″; slate 0′ 1″; bottom bench 0′ 2″: analysis from sample submitted by the company shows F. C. 71.656%, V. M. 19.144, sulphur .464% and ash 8.220%. As far as my obervation extends, this bed shows at its best at this point. The mine seems free from rolls and the coal therefor shows its full thickness, while its chemical analysis is very favorable.

The Kister opening on same bed, opposite side of railroad, shows the coal



a far better mining section in the *Second basin* in northern Somerset and such an improvement in chemical character as to show results quite as favorable as the *Miller seam* in the *Scalp Level district.*

The *Brookville bed A* has no value attached to it in the First basin, though it is exposed above water level from Scalp Level on Paint creek, around the face of Stony creek to Foustwell and up Shade creek for several miles. A characteristic section at Ott's mill, plate 424, shows 1′ 10″ of slaty coal; 4″ of slate parting, 2″ of bone and 3′ 6″ of bottom, hard, sulphurous coal.

Quemahoning creek runs through the western side of the *Wilmore basin* for about 5 miles between Bethel and Morgan's mills before cutting through the Viaduct axis into the *Johnstown basin.*

At Morgan's mill the *Conglomerate No. XII* is brought to daylight and the three lowest beds A, B and C′ of the *Lower Productive series* outcrop in the hillside east of the woolen mill. Bed A is reported to be full 3′ thick, but worthless.

Bed B is opened at a number of places here and towards Bethel, everywhere yielding a rich pure coal, generally accessible. At the Morgan mine it is 4′ 2½″ thick, the top bench 3′ thick, with two thin slate partings enclosing a 3½″ middle coal, leaving 10″ of coal in the bottom. The coal is remarkably pure*.

The *Upper Kittanning C′* bed outcrops on the D. Weaver property 2 miles below Morgan's, where it is only 40′ above the creek as against 250′ at the mill. It shows one solid bench 3′ thick as in all northern Somerset, with a cuboidal structure, and the coal hard and bright, almost directly underlaid by 6′ of cement rock.

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thickness; but as seen in the mines it nowhere exceeded 3′ 6″, with 2″ top bony coal and a thin slate about 3″ above floor. The valley of Beaver Dam creek being very flat and wide, furnishes many excellent shaft sites for developing this portion of the field; but as bed E lies close to water level throughout the basin here, shafts of 80′ and 150′ in depth will be necessary to reach the underlying thicker and better coal beds C′ and B.

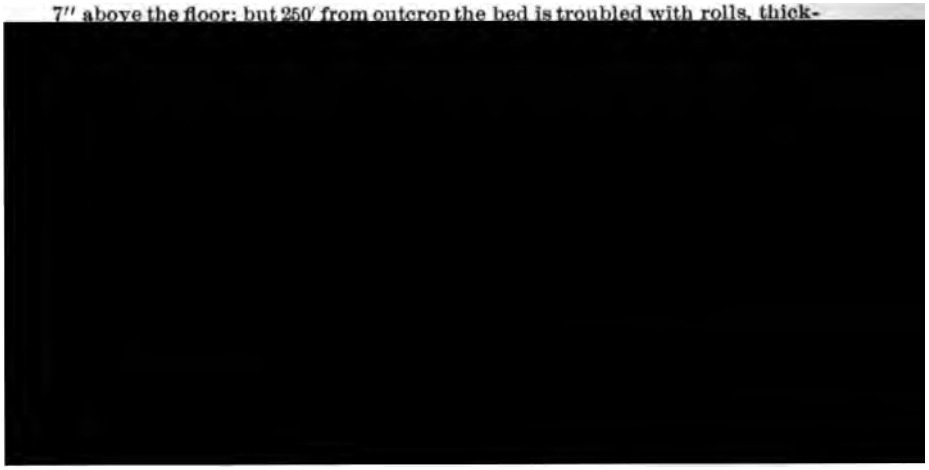
*In the *Bowman mine* and at *William Apple's opening* at the head of a small branch of the creek the coal shows a very similar section only both middle and lower benches are 5″ thick.

Coxe's creek rises at the summit near Geiger station and flows soutward along the railroad to the Castleman river at Rockwood, receiving Kimberlin's run from Fairview village on the east and the West branch and Rice's run from the west above and below Milford station. East of the basin line and the railroad the *Lower Productive rocks* occupy the surface of the region; to the west of the synclinal the *Barren Measures* are the surface rocks as far south as Milford, beyond which to the lower end of the basin at Weimer's grove, these rocks only occupy detached summit areas.

The *Lower Kittanning bed B** is opened on the Zimmerman farm about 1⅛ miles southwest of Fairview, although all the upper beds of the series outcrop in this vicinity. The bed varies both in quality and thickness and in this mine shows an average section of 4′ carrying 4″ of slate a foot above the bottom. Sometimes it yields a good clean coal and again the bed is both slaty and pyritous so that any single sample is liable to do more or less injustice to the commercial rating of its fuel.

The *Upper Kittanning bed C*† is found about 75′ above

* At Milford station the same coal is opened at a number of points. The *Ankeny mine* shows a partial section; top bench 2′ 2″; a half inch slate parting and then 8″ of coal. Though manifestly sulphurous, it makes a quick, hot fire and a good engine fuel, producing little smoke. In the *Brandt mine* near mouth of drift, the normal section shows 3′ 7″ with a 3″ parting 7″ above the floor; but 250′ from outcrop the bed is troubled with rolls, thick-



the Zimmerman mine near Fairview, and shows about 3′ of coal including a small parting of slate and underlaid by about 6′ of highly impure limestone, containing nearly 4½% of carbonate of iron and 25% of siliceous matter. This bed crosses the Negro Mountain anticlinal intact and has been exposed on the farms of G. Walker and D. Coleman.

Around Milford and further south bed C′ is invariably a double bed of very irregular thickness, as opened by Mr. Stutzman showing its characteristic fire clay shale parting 1′ thick, in a total thickness of 5′. The bed has never been mined in this vicinity, but is known to exist in Coxe's Creek valley almost all the way from Somerset to the Casleman river. It is however decidedly the most important bed of the series, whilst its superiority is attributable largely to the increased thickness of the seam. On Rhoades run it yields upwards of 7′ of coal on the Joseph Myers farm, parted near the center by a band of fire clay shale ranging from 4″ to 1′ in thickness, and on adjoining property increasing to 2′ or more. Throughout this region the swelling of the dividing shale invariably increases the thickness of the lower bench, the upper portion of the bed remaining regular. Moreover the two benches of coal differ widely both in structure and quality. The lower bench is firm, compact, and bedded in horizontal layers; much intermixed with slate, possessing a dull lustre at the fracture and breaks up into blocks in mining. Still it makes a stronger and hotter fire than the upper bench which yields a much softer coal, of columnar structure, unevenly divided by a thin but persistent slate band.

The *Lower Freeport bed D* is present as a thin bed throughout this whole basin. In the Fairview region it is 2′ 6″ thick separated by 2′ 3″ of fire clay shale from its limestone bed 3′ 6″ thick. The coal is bright, moderately soft and mines easily*. It shows rather a large amount of

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Somerset, and where shafted upon at water level it carries 3″ of top bony coal, an upper bench 2′ 3″; slate parting from 8″ to 13″, and a lower bench 1′ 6″.

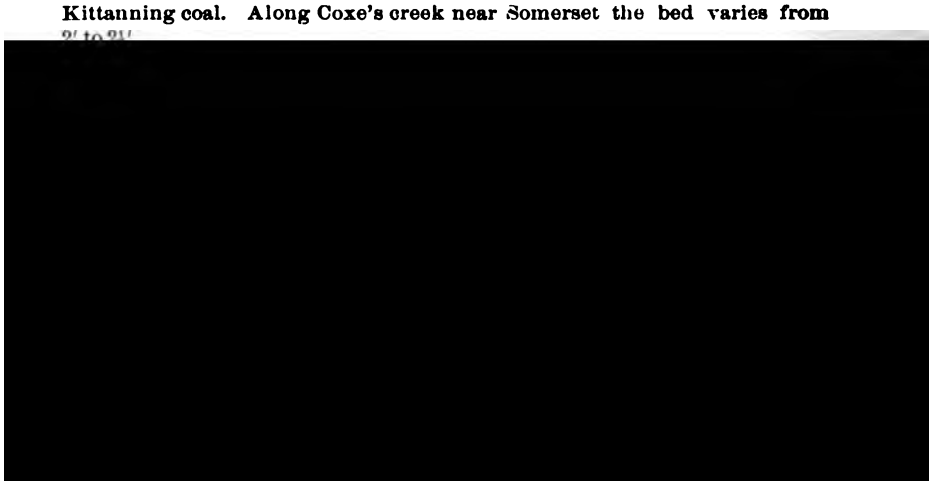
*In the *Schaeffer mine* it shows same thickness but separated from its limestone by from 4′ to 8′ of fire clay and occurs about 35′ above the Upper

iron pyrites and practically the same section and character at the *Will mine* to the north-west.*

Upper Freeport coal bed E is likewise a thin seam, confined mainly to the hill tops along the Bedford pike and through the centre of the basin south of Milford station. Its outcrop is present, but sparingly opened, in the Fairview district along the Bedford pike, and where opened at the *J. Schaeffer mine*, about 60′ above bed D, it shows bright handsome coal with a knife edge of slate about a foot above the floor. It makes its appearance on the western side of the basin just west of the outskirts of Somerset, and ascending the hill on the western side of Coxe's creek it has been opened at several places on Mr. Hughes' land, where it is 3′ 9″ thick but largely spoiled by carrying 4″ of bony coal on top and two partings of an inch thick near the bottom. The coal is soft and easily mined and holds apparently a small amount of sulphur. It cokes easily being preferred to either of the lower coal beds of this region: but aside from all other considerations, the amount of slate in the bed is injurious to its character as merchantable coal.†

Between Rockwood and the great Pinkerton bend the Castleman river runs obliquely across the *Wilmore basin* before cutting through the *Viaduct axis* and joining the Youghiogheny at Confluence in the *Johnstown* or *Second*

Kittanning coal. Along Coxe's creek near Somerset the bed varies from 2′ to 2½′



basin. The *Castleman river section,** as compiled in plate 421 shows the entire *Lower Productive Measures* to be present here, together with a considerable covering of the *Barren Measures.* The section is similar to those made in Clearfield, Cambria and Centre Cos. in the north, not only in its main features, but also in its remarkable resemblance to them in its minor details. The most notable exception is the introduction of the persistent *Johnstown cement rock* and the thickening of its overlying *Upper Kittanning coal bed C'*, which first makes its appearance in Cambria Co., follows southward into northern Somerset as a

*Coal A along Castleman river is present as a 3' 6" bed, but generally worthless. The fire clay deposit, occuring below this coal at Shoo fly tunnel on the B. & O. R. R., is an almost unfailing accompaniment of this seam, though unusually impure and abnormally thick there.

This is probably the most persistent and important fire clay deposit in the coal measures, supporting the well-known fire brick works at Sandy Ridge, Powelton, Blue Ball, Wallaceton, Woodland and Hope station in Clearfield Co., Benezette in Elk Co.; Brookville in Jefferson Co., and at Queen's Run and Farrandsville in Clinton Co.

Bed B comes in 80' higher in the Castleman section; but very little is known of the character of this bed in this valley, and there seems to be good reasons to believe that it is of little importance economically, being certainly thinner than it is throughout northern Somerset Co.

Bed C, 30 higher, is here as elsewhere a worthless commercial coal about 1' 6" thick.

Bed C' is the most important bed of the series here. Its coal is somewhat slaty and pyritous, but easily mined and suitable for domestic purposes and for calcining its underlying magnesian limestone. It is easily recognized by its occurrence above this cement rock and beneath the heavy massive Freeport sandstone; but the thick band of impure fire clay shale, dividing it into two benches, is an unfailing guide to its identification along the Castleman, thicker here than elsewhere.

The Freeport sandstone, though of variable thickness, becomes a conspicuous feature of the Castleman river section, being massive and making bold cliffs, 20' high along the river. It has a somewhat pebbly character, its pebbles being usually elongated.

Coal D is little known between Mineral Point and Turkey Foot; for being usually only about 2½' thick, it cannot be mined with profit even for domestic purposes. Indeed it is not known at all in the Fort Hill and Harnedsville regions along the river in the Johnstown basin; nor at Ursina or Laurel Hill run. (See plate 426).

Coal E, 110' above C', lacks significance, economically considered, owing to its attenuated condition. It is frequentiy underlaid by moderately pure limestone, which calcines easily, and is therefor much sought after by the farmers.

3½′ single bed, and south of Stoystown parted into two benches by a persistent and ever increasing fire clay shale parting, which becomes from 2′ to 3′ thick in southern Somerset.

The *Lower Productive Measures* are almost entirely above water level at Mineral Point in the *Wilmore* or *First basin.* Coal A has been opened high up on the flank of Negro Mt. on the *Vogel farm* where it is reported to measure 6′ thick, but largely intermixed with slate and sulphur bands. The *Clarion bed A′* has likewise been opened nearer Mineral Point on the *Wolfesberger farm*, with a thickness of 3′, reaching water at Mineral Point.

Bed B also shows here as a double bed, about 4½′ thick, of which 3½′ is good coal. It has one conspicuous parting 1′ thick above the bottom bench of coal, also 1′ thick. In the upper bench of 2′ 6″ it carries two knife edge slates. At Schaff's bridge about 1 mile below Mineral Point, this bed is said to yield as much as 4′ of good coal, opened 40′ above the river.

Bed C′ is first opened on the *Wolfesberger property*, measuring 6′ from floor to roof, but parted by a thick band of fire clay near the center.* Around Centreville, on the Clay pike, a number of openings have been made on this same bed and 1½ miles south-east of Castleman village it is mined by *Henry Sechler* with a top bench of 3′; slate 2″ and coal 8″, carrying iron pyrites in abundance.

These measures are again exposed for 100′ in an exten-

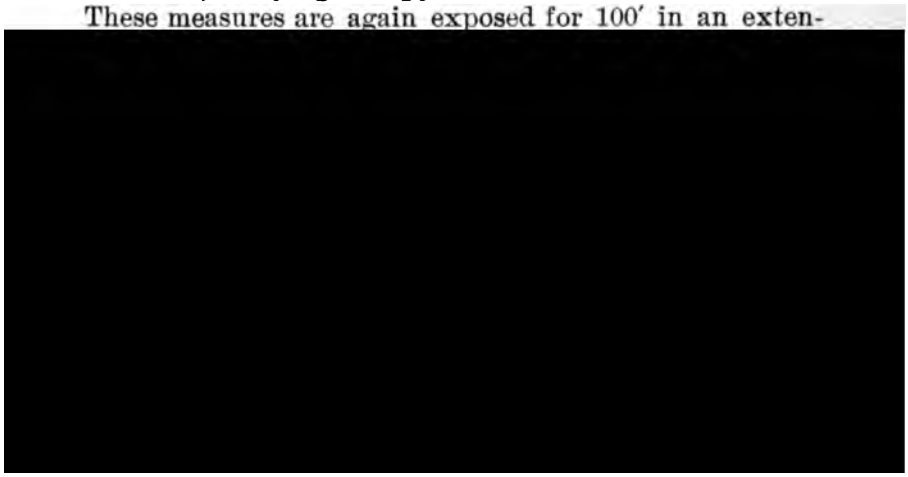


PLATE 426.

No XIII and XIV Vertical Sections in Somerset County, Pa

The Barren Measures and Allegheny Coal Series in the Second or Johnstown Bituminous Basin

SECOND GEOLOGICAL SURVEY OF PA.
1876

Fig. 96.
Ursina.
Barren Measures No XIV

Fig. 93.
Laurel Hill Creek.
Allegheny Coal Series No XIII

SECOND GEOLOGICAL SURVEY OF PA.

Fig. 101.
Harnedsville.
Barren Measures
No XIV
Alle. Series
No XIII

Fig. 100.
Opposite Fort Hill.
Allegheny Series No XIV
Coal Series
No XIII

SECOND GEOLOGICAL SURVEY OF PA.
1876

Fig. 107.
CONFLUENCE.

SECOND GEOLOGICAL SURVEY OF PA.
1876

Fig. 98.
Forwardstown.
Barren Measures No XIV

Fig. 92.
J. T. Yoder.
No XIV
No XIII



are mined on the *Nicholson farm* and the poor quality of the lower bench was proved by its analysis showing no less than 3.11% of sulphur and 27.30% of ash. The upper bench showed V. M. 71.32%; F. C. 19.82; Sulphur 1.53 and Ash 6.49. The *Heinbach mine*, still further south-west, shows the coal 5′ 6″ thick; but it carries 3″ of top bony coal; 2′ of good coal in the upper bench; bone and fire clay shale parting 2′ and bottom coal 1′ 3″, the latter being again inferior.

The *Second or Johnstown–Confluence basin* extends from the Cambria line to the Youghiogheny river as a synclinal about 7 miles wide, bounded by the Viaduct and Laurel Hill anticlinals.

The *Pottsville Conglomerate* is uncovered all along the top of the mountain from the Conemaugh to the Youghiogheny. A thin covering of the *Lower Productive Coal Measures* overspreads the lower portion of the eastern slope of Laurel Hill, and where this mountain is cut through by the Youghiogheny river in a gap 5 miles in length, even the Pocono sandstone formation No. X is exposed on the arch. Vertical sections of Nos. XIII and XIV in this basin are given on plate 426.

The *Upper Freeport coal E* lies just above water level in the heart of the basin along Bens creek near the Cambria Co. line, and its outcrop may be easily followed for 3 miles up the two branches of Bens creek, though it is rarely a commercial coal.

In the *Croyle bank* it shows a main mining bench from 3′ 6″ to 3′ 10″ separated by 3″ of slate from an upper coal bench 6″ thick not mined. "Sulphur balls" are occasionally met with in mining, but to no unusual extent. The same coal bed is opened at the *Thomas mine*, 3 miles up the south branch, where the mining section will not net over 3′ 6″, although the whole bed is locally enlarged here with 6″ of top impure coal; 1′ of slate with thin seams of coal, both above the main bench; and 3″ of slate and 1′ of hard bony coal not mined at the bottom of the bed. (Plate 427.)

The *Upper Kittanning coal C'* shares with the *Lower*

Kittanning coal B the reputation for commercial coal of the region. It underlies the Upper Freeport coal by about 80′. On the western side of the basin, along tthe waters of Bens creek, it is opened at several places, furnishing from 3′ 0″ to 3′ 6″ of clean coal, of fair quality, in one bench. Along Stony creek and along the branch heading up towards Davidsville, it is in much better condition, showing one bench nearly 5′ thick of which the top 9″ or 10″ is bony and the bottom 4′ good coal. On the south branch of Bens creek it is mined by *Levi Kauffman*, *Cable*, *Wertz*, *Forest Heirs* showing everywhere from 3′ to 3½′ thick and separated by thin slate parting from its cement limeston floor. It rises just about with the water towards the Viaduct axis along the Davidsville branch and is opened on the *James*, *Kauffman* and *Yoder farms*, mining out in good lump sizes and carrying some sulphur balls and thin plates of iron pyrites; on the whole a satisfactory steam coal.

The *Lower Freeport Coal D*, is everywhere thin through the northern part of this basin but attains a certain amount of importance from the fact that though scarcely reaching 2′ in thickness, it is nearly everywhere underlaid by from 2′ to 3′ of good limestone, which justifies its development locally for calcining purposes.

Around Jennerstown and Jenners cross roads the beds of the *Lower Productive Coal Measures* are exposed along the Bedford pike on branches the Quemahoning creek.*

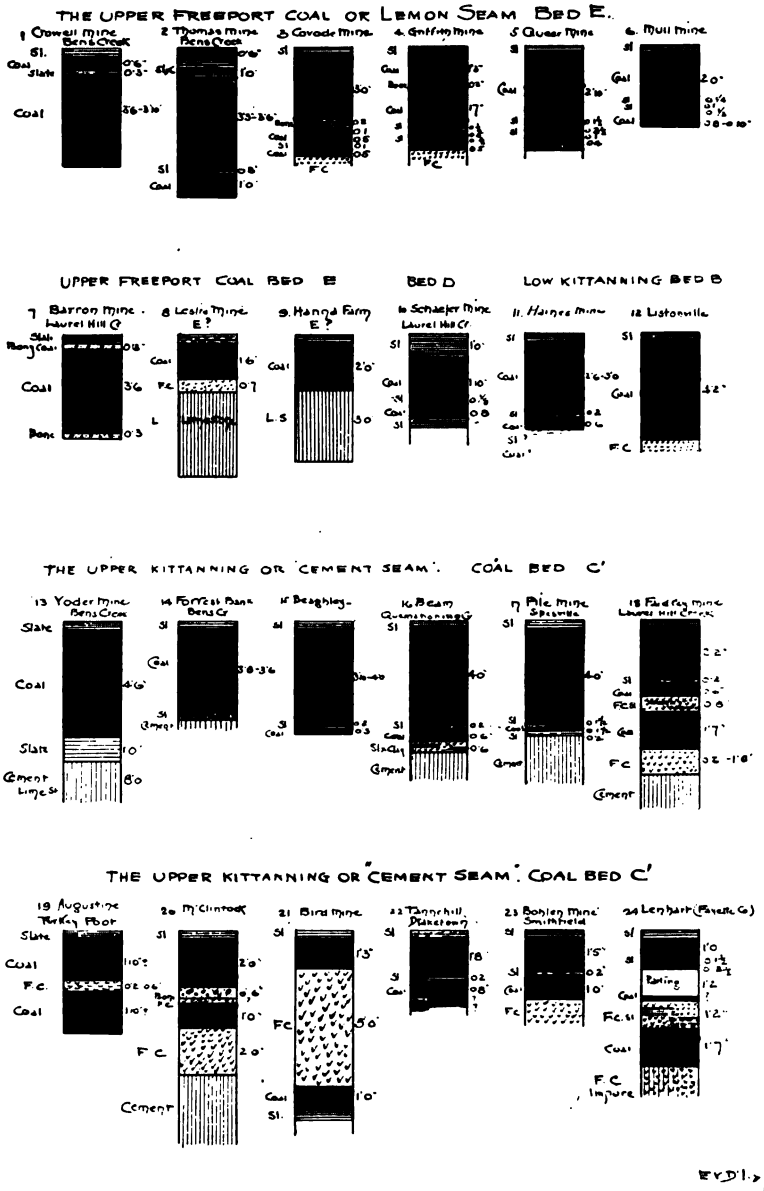


PLATE 427

No XIII. Allegheny Coal Series in Somerset County, Pa.

Coal Bed Sections in the Second (Johnstown) Basin

Scale 8 feet = 1 inch



EVD 1.



South of the divide between the waters of the Conemaugh and Castleman the developments on the *Lower Productive coals* are confined almost entirely to the western side of the basin along branches of Laurel Hill creek, descending from the mountain.

At Bakersville the two Freeport coals* have been opened. Both beds are again reported with thicknesses of 5′ and 4′ near Kings bridge, at the crossing of the Clay pike.

The *Upper Kittanning bed C′* † was also once opened here and is reported to yield on an average of about 5′ of coal, separated into two benches by a thick band of impure

---

to the earthy matter mixed with it, so that an analysis of the entire 4′ would hardly yield the excellent result recorded of the center portion. Both the Freeport coal benches show above this mine.

The *Beaghley bank* (bed C′) close to the Viaduct axis on headwaters of Quemahoning creek shows coal exceedingly regular and attractive. Upper bench 4′ is only spoiled by carrying knife-edges of slate difficult to separate in mining; a persistent 2″ parting divides it from a lower bench 3″ thick. The upper bench, from a personal sample, shows sulpher .570% and ash 11.675%. In the *Pile mines* north-east of Sipesville the top bench is again 4″ thick; the slate parting 1½″ and the bottom coal 1½″, the top coal again being mixed with almost imperceptible seams of slate, adding largely to the percentage of ash.

Bed E is believed to be the bed opened about 1¼ mile due west of Sipesville on the *Berkey* and *Queer properties* where it shows 3′ 8″ thick with two thin partings near the center.

* Bed D at the Schaeffer mine, near Schaeffer's mill, 2′ 6″ thick with a thin parting 8″ above the floor; bed E, 60′ higher at the Mull mine, 2′ 11″ thick with two thin partings from 8″ to 10″ above the floor, enclosing 1″ of coal. The upper bench is soft and good coal. Both these beds show on the John Neer farm, bed D with precisely the same section and yielding a good coal for local wants. Bed E is unopened here; but at the *Putman farm*, further down stream, it is 3′ 3″ thick with a slate band from 1″ to 3″ thick about 6″ from the floor. At the *Barron mine* 1 mile south-west, it has been extensively worked 4′ thick, carrying two 3″ bands of bony coal on top and bottom.

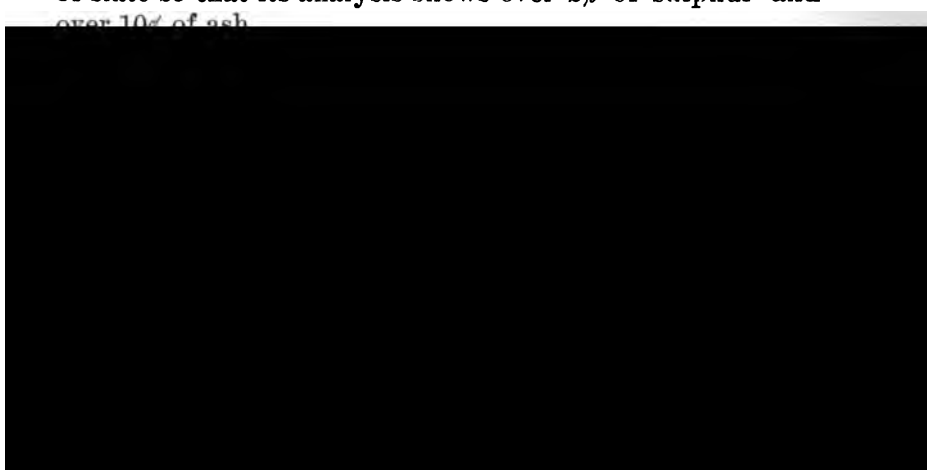
† On the *Faideley property*, about 3 miles south of King's farm this coal and limestone have been completely exposed. The bed shows three benches, 2′ 2″, 0′ 8″ and 1′ 7″ thick, wih partings of 2″ and 8″. All three benches yield impure and firm coal, mining out in cubical blocks, the coal in the lowest bench being particularly hard and compact, from contained earthy matter, and bedded in horizontal layers. At the mouth of Brown's run, near the old abandoned workings on the *Rose* or *Philson coal* of the *Barren Measures*, bed C′ was opened at the *Crowl mine* and is here represented as a double bed, little more than 2′ thick, parted by 3″ of slate near the center. Bed E was partially opened here at the old Rush mine showing 2½′ of inferior slaty coal of no commercial value.

fire clay shale as in the First basin along the Castleman river. The Johnstown cement is nearly 6′ thick and as usual divided into three distinct layers, of which the middle one furnishes the best stone.

At the *Scott mine*, near Ursina, bed C′ is again opened, having fallen about with Laurel Hill creek to this point. It shows its characteristic slate parting and limestone and sinks at once below the creek going west from the Scott mine. It is under water level at the Ursina bridge but reappears beyond Confluence to ascend the slope of Laurel Hill. It is known to exist at Draketown.*

Around Harnedsville bed C′ is again the chief source of a fuel supply, its upper bench being about 3′ thick below which comes a variable fire clay parting and a bottom bench from 6″ to 10″. Bed B is supposed to crop near water level from 2′ to 3′ thick. Bed E is 100′ over C′ and only 2′ thick over limestone.

Along White's creek these same coals are exposed with nearly similar section (See plate 427); bed C′ at the *McClintock mine* 3′ 6″ thick, the parting 6″ thick, dividing the bed into benches of 2′ and 1′ in thickness and associated with bony coal; bed E 2′ on Hannah's land; and bed B in unusually good condition above *Listonville*†, in one compact bench 4′ 2″ thick. Its handsome section however is spoiled by a large amount of iron pyrites and thin seams of slate so that its analysis shows over 2% of sulphur and over 10% of ash.



the *Upper Kittanning C'* and *Upper Freeport E* have been opened at some few places; but these exposures call for no special comment.

South from Confluence to the Maryland line the *Barren Measures* largely occupy the basin, the *Rose* or *Philson bed* just touching water level on reaching the town. Ascending the stream to a point within 3 miles of Smithfield, the *Upper Kittanning* and *Freeport coals* are found above water level on the Bohlen farm, the former showing an impoverished section 2′ 7″ thick, with 2″ of slate 1′ from the floor. Bed E is 3′ thick, half good coal and half bony coal. At Smithfield, bed C′ is above water level on the Fayette Co. side and is mined at several points. It is 4′ 1″ thick but carries three bands of slate. The variations of these several coal beds in the Second basin are graphically shown on plate 427.

*No. XIII in Bradford and Tioga Counties.**

Returning now to the northern end of the Bituminous Coal Field of the State, to take up a second and more western tier of coal bearing counties, the Bradford and Tioga Co. maps will show the presence of three widely separated and rudely parallel coal basins, containing narrow and detached areas of the *Lower Productive* (Allegheny River) *Coal Series*, only two of which have been found to contain commercial coal beds, as follows: 1st. The *Barclay* (Towanda) *basin* of Bradford, and 2d. The *Blossburg basin* of Tioga Co.

Both basins are characterized by containing many patches of the lower coal measures, so numerous as to render it difficult, if not impossible, to portray them without exact and definite instrumental surveys. These advantages were not vouchsafed during the period of their examination (1878) and consequently, so far as the Survey records are concerned, much of value and interest developed by more recent mining work there awaits the provision of a second

*Report G: F. Platt, 1878.

examination. No survey of the Armenia Mountain top was made at all, so that it is still uncertain whether workable coals exist there or not, in the northeastern extremity of the Tioga Co. coal basin.

The *Gaines coal basin* of Potter Co. extends geologically and topographically into the central part of Tioga Co., but with its trough largely filled with Conglomerate No. XII, the coal measures occupying two detached knobs along the Potter Co. line, separated from each other by the valley of Long run. These summits are 2200′ above tide, and contain what remains of the three so-called "*Three foot*," "*Four foot*" and "*Five foot*" coal beds, lying nearly flat at elevations of 1000′ above Pine creek and Long run. (Plate 428).

The famous and well known *Blossburg basin* parallels this Gaines basin, but 16 miles to the southeast, the intervening anticlinal having been eroded down to the Chemung rocks. This coal area is about 16 miles long and 4 mile wide; but the basin continues into Lycoming Co. where the highest ridges are capped with Conglomerate and and patches of the lowest coal measures.

The *Barclay basin** is the only synclinal holding coal in Bradford Co. and is a moderate sized area, confined to Barclay and Leroy twps.; well defined topographically and geologically—a table land bounded on the north by the Towanda mountain 2000′ A. T. Schroeder creek is practically the south line of the *Lower Productive Coal Meas-*

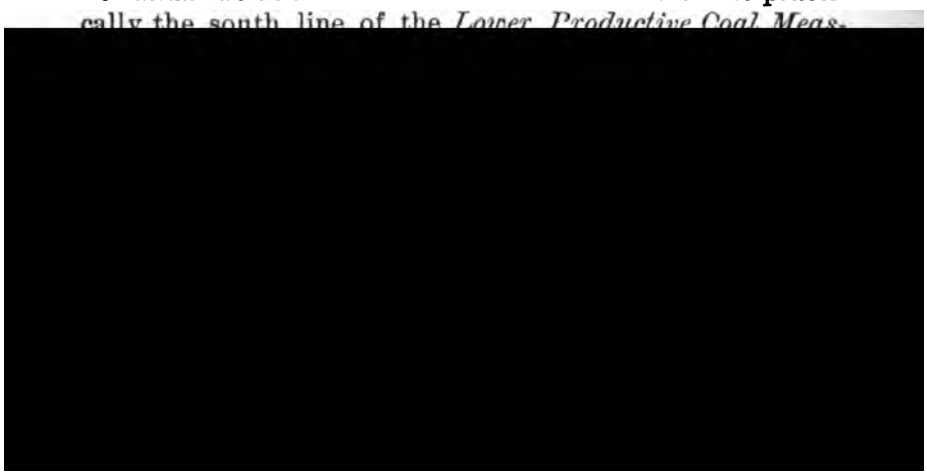


PLATE 428.

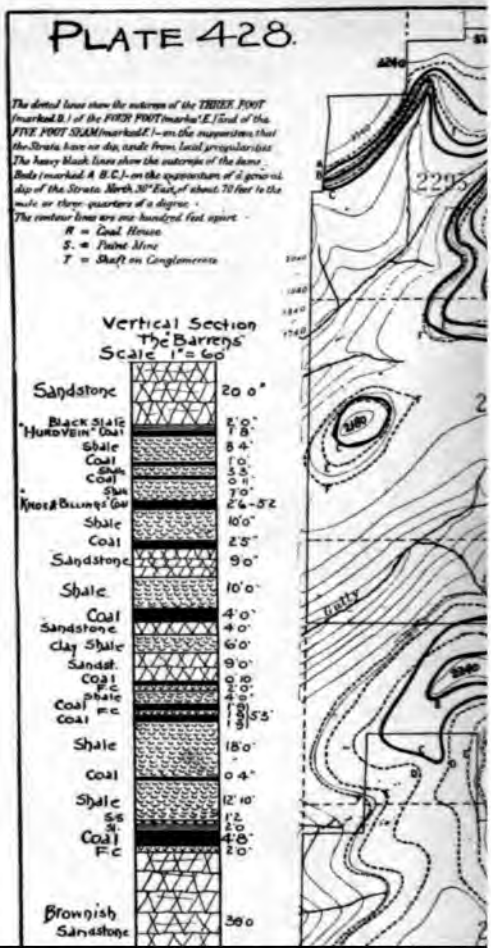
The dotted lines show the outcrops of the THREE FOOT (marked B.) of the FOUR FOOT (marked E.) and of the FIVE FOOT SEAM (marked F.) — on the supposition that the Strata have no dip, aside from local irregularities. The heavy black lines show the outcrops of the same Beds (marked A. B. C.) — on the supposition of a general dip of the Strata. North 30° East, of about 70 feet to the mile or three-quarters of a degree.

The contour lines are one hundred feet apart.

H = Coal House.
S. = Paint Mine.
T = Shaft on Conglomerate.

Vertical Section The Barrens Scale 1" = 60'

Sandstone	20 0"
Black Shale "Hurd Vein" Coal	2' 0" / 1' 8"
Shale	8 4"
Coal	1' 0"
Shale	3 5"
Coal	0 11"
Shale	7' 0"
Knob & Billings' Coal	2'6" - 5'2"
Shale	10'0"
Coal	2'5"
Sandstone	9'0"
Shale	10'0"
Coal	4'0"
Sandstone	4'0"
Clay Shale	6'0"
Sandst.	9'0"
Coal F.C.	0 10 / 2'0"
Shale	4'0"
Coal F.C.	1'8" / 1'5" / 1'5"
Shale	18'0"
Coal	0 4"
Shale	12' 10"
Ss & Sh.	1'2 / 2'0
Coal F.C.	4'8" / 2'0"
Brownish Sandstone	38 0



[redacted]

428.

TOPOGRAPHICAL MAP

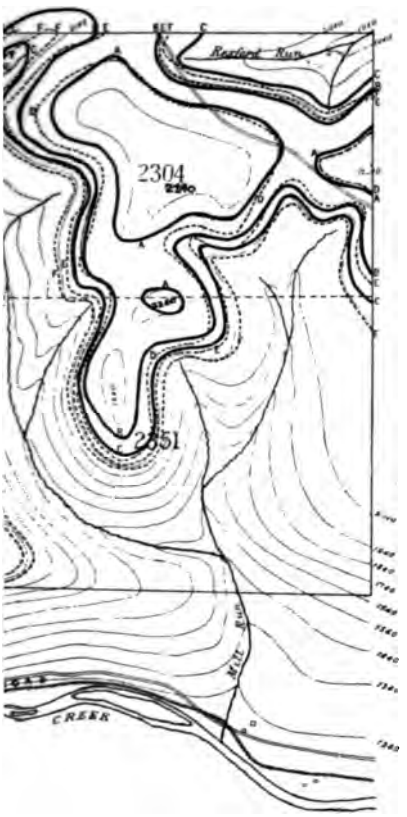
OF THE

GAINES COAL BASIN

IN GAINES TOWNSHIP TIOGA COUNTY.

Contour Curves 100 Feet apart.

Scale of Feet.





to 22% volatile matter, and 6 to 8% of ash, with benches of cannel-like structure, having 12 to 16% of ash. The beds in the western part of the field carry local names, from above downward, as follows (see plates 429, 430, 431):

7. *Rock Vein.*
6. *Seymour or Cushing Vein.*
5. *Morgan or Dirt Vein.*
4. *Cannel Vein.*
3. *Bloss Vein.*
2. *Bear Creek Vein.*
1. *Kidney Vein.*

The *Bloss vein* or *Bed B* is most esteemed and most mined, with four persistent benches, separated by thin parting slates.

The iron ore deposits of the coal measures received considerable attention in early years; but they are not regarded as of much value, being almost entirely kidney or ball ore, neither rich enough or persistent enough to work with profit.

In the *Barclay basin* the bottom coal A* is thin (2′ to 3′) and not now worked; but bed B, 60′ to 80′ higher, has been long famous for the excellent steam raising qualities of the coal, while taken in connection with its proximity to market (37 miles to Sayre and 119 to Geneva), has rendered the development of this basin and the sale of its product comparatively easy and successful. These two beds are the only ones of importance in this basin, and are locally referred to as the upper or "*Big Vein*" and the lower or "*Three-foot Vein*".

Average analyses of each of the two coal beds, A and B, from early samples of Prof. Johnson show:—

	Carbon.	*Volatile Matter.*	*Earthy Matter.*
Coal A, 3 samples,	65.5	17.17	17.33
Coal B, 5 samples,	69.23	19.16	11.61

* Mr. Taylor's section of the lower bed at the head of Fall creek shows no less than five benches of coal from above downwards respectively 12½″, 2″, 9½″, 4″ and 5½″ thick, separated by slate bands of 5″, 4″, 1″ and 2″, or a total of 31½″ of coal. Another section of the same bed shows but two benches, 16″ and 15¾″, separated by 2″ of slate. The upper bed in one place shows coal benches 32″, 19½″ and 21″ separated by slate 4″ and 7″. A second opening, coal benches of 35″, 6″, 20″ and 6″ and slate partings of 11″, 5″ and 3″; mining coal 5′ 1″.

J. T. Hodge in the *First Geological Survey*, 1841, gives a section of the measures exposed at Fall creek, reproduced in plate 429, in which the two coal beds are found 81′ apart. The upper or main bed is found from 4′7″ to 5′7″ thick, worked at *Mason's*, and at *Gatiss'* where it was found 5′ 9″ thick, sandstone roof and fire clay floor.

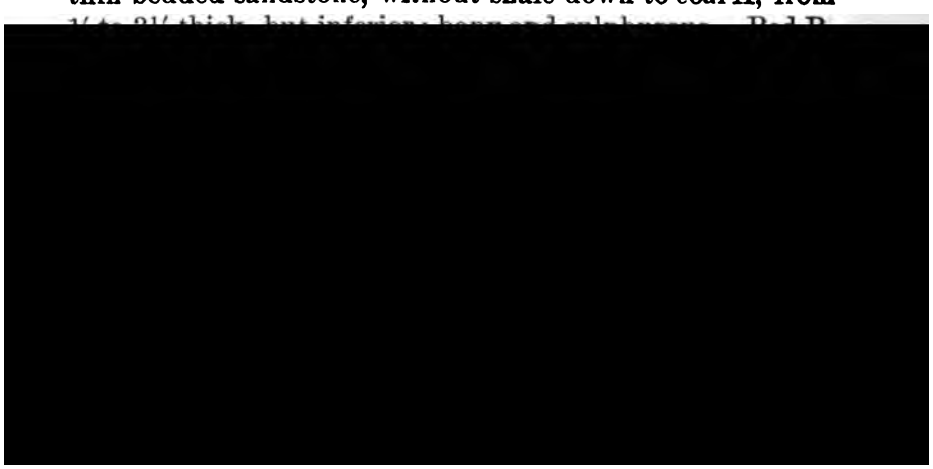
It showed there the following typical section: (See plate 432).

Bed B: Gatiss Mine

Coal, not mined, very bituminous,	0′ 8″ to 0′	10″
Parting.		
Coal,	2′	4′
Slate,	0′	9′
Coal (blacksmith band),	0′	6″
Slate,	0′ 4″ to 0′	5″
Coal (suitable for grate),	1′	8″
Slate,	0	6″
Coal,	0	6″
Fireclay.		

The lower bed A is about 3′; the only one found on the mountain between Carbon creek, Middle branch and South branch.

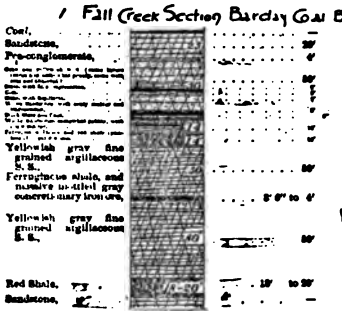
The Messrs. Lesley note the presence of sandstone and shales as the highest coal measure rocks of the *Schroeder creek region*, "carrying a layer or two of very hard and sometimes pebbly rock"; under them lies Bed B, 5½′ to 9′ thick. Then 80′ of interval, shale and sandstone and flinty thin bedded sandstone, without shale down to coal A, from



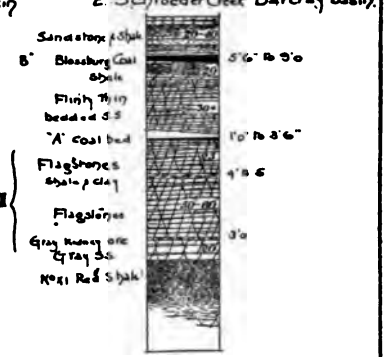
No XIII Allegheny Coal Series. Bradford and Tioga Cos

Vertical Sections in Bradford Co

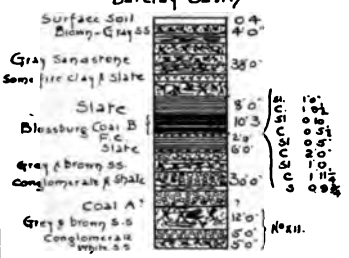
1 Fall Creek Section Barclay Coal Basin



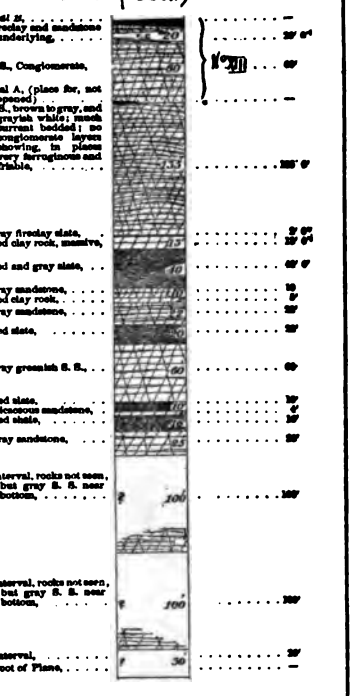
2 Schroeder Creek Barclay Basin.



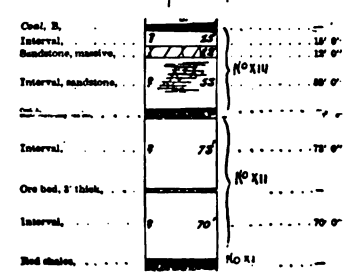
3 Barclay Coal Co Bore Hole Barclay Basin



4 Barclay R R Incline Plane Barclay Basin



5 Coal Run Section Barclay Basin.





Coal bed B is the bed which has given in the past and now gives value to the *Barclay coal basin.* Large amounts of coal have been mined from this bed at the *Barclay mines* of the Barclay Railroad & Coal Co. and from the *Schroeder mines* of the Carbon Run Coal Co.

In its normal condition it is always a tripple bed, consisting of three benches of coal separated from each other by varying thicknesses of slate. The lower bench coal is friable, columnar, deep black, free from slate. The middle bench is friable, columnar and black. The upper bench, cubical, harder, does not crumble and has no regular slate layers. Typical measurements of this bed, taken from notes of F. F. Lyon, formerly chief engineer of the Barclay mines, show the following variations in different parts of the mine: (see graphical illustrations, figs. 3, 4 and 5 on page plate 432).

	No. 1.	*No. 2.*	*No. 3.*
Coal, top bench.	1′ 9″	1′ 10″	1′ 6″
Slate,	0′ 8″	0′ 2″	2′ 0″
Bone coal,	0′ 6″		
Coal,	0′ 8″	0′ 6″	1′ 3″
Slate,	0′ 6″	0′ 6″	0′—6′ 0″
Coal, bottom bench,	2′ 6″	0′ 10″	2′ 9″

These variations are very great and in comparatively short distances; and this is characteristic of the whole basin. However taking this coal bed B with all its variations at the Barclay mines, and it averages about 5,000 tons to the acre, or 3½′ of clear coal. Various analyses of this coal are given in report G page 132; but an average specimen, representing the "run of the mines" as shipped to the market, yields on analysis as follows:—

Water,	.770
Volatile matter,	17.110
Fixed carbon,	70.744
Sulphur,	.776
Ash,	10.600

The *Schroeder mines* on Carbon run are also opened on bed B where a measured section is as follows:—(Plate 432 fig. 6).

1. *Coal*, upper bench, friable and columnar, irregular, good character; blacksmith coal, . . .	0′ 1″—0′ 6′
Slate parting, ...	0 1″—1′ 6″
2. *Coal*, middle bench; harder, cubical structure, .	3′ 7″
Slate, ...	0′ 2″—0′ 7″
3. *Coal*, lower bench; friable and columnar, ...	1′ 8″

Analyses of the middle and lower benches gave:—

	Middle.	*Lower.*
Water, ...	.940	.850
Volatile matter, ...	17.845	16.755
Fixed carbon, ...	72.155	69.390
Sulphur, ...	.670	.715
Ash, ...	8.390	12.290

The yield of coal is about 6,000 tons an acre and this may be taken as the average yield in the western part of the Barclay basin. The analysis of the middle 3′ 7″ bench shows results quite similar to the Barclay mines, with a slightly decreased percentage of both sulphur and ash.

To the east of the Barclay mines there are numerous trial openings on bed B, but no mines opened for shipment. On McKraney's run the bed shows in a nearly solid bench 5′ 9″ thick; but at the extreme east end of the basin, at the old Mason mines, the bed is again split up with thin slate and bony partings, in all 4′ 7½″ thick, but so intermixed with fine layers of slate as to add largely to the percentage of ash in the coal. Such is the condition of the coal also in the old Northorp mine, where the coal has a massive sandstone roof, filled with *Lepidodendron* impressions. (Plate 432 fig. 9.)

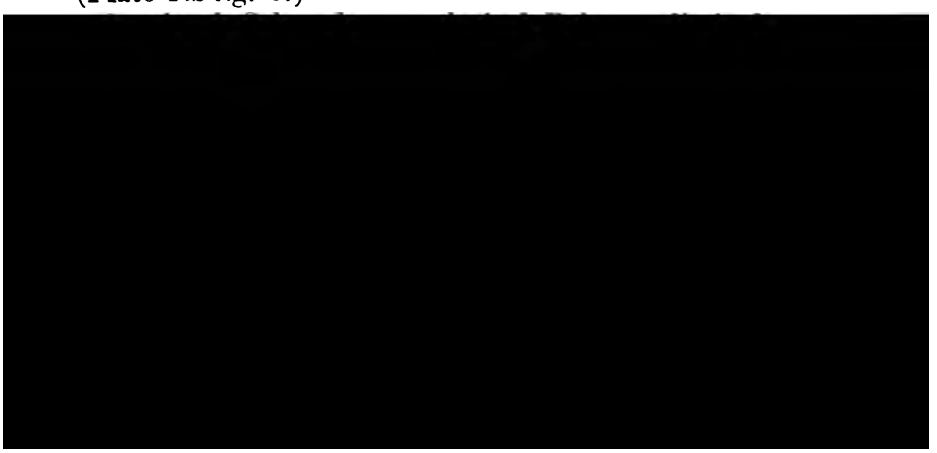
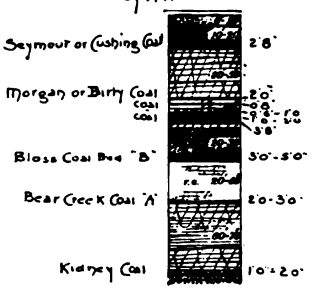


PLATE. 430.

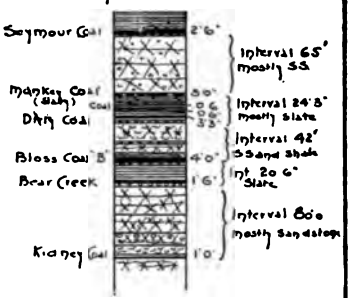
No XIII. Allegheny Coal Series. Bradford and Tioga Counties

Vertical Sections in Tioga County, Pa.

1. Fall Brook Section. by A Hardt

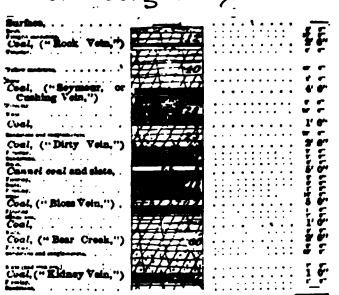


2. Fall Brook Section by F. Platt.



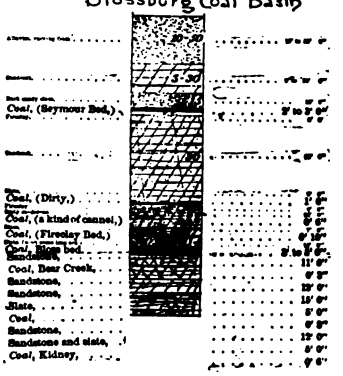
3. Morris Run Section W. S. Keering

Blossburg Basin.



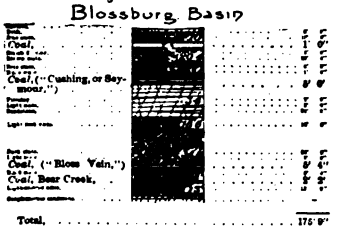
4. Arnot Section. by S. B. Elliott

Blossburg Coal Basin

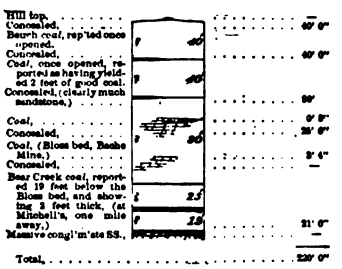


5. Antrim Mines Section by Anton Hardt

Blossburg Basin.



6. Bache Mine Section





ter coal has been opened in many places it has been nowhere mined for shipment. On Fall creek it shows two benches, 7″ and 6″ thick, separated by 8″ of slate; but in many other trial pits it shows from 2½′ to 3′ of fair coal. Analysis: Water .850%; V. M. 16.625%; F. C. 67.292%; Sulphur .498% and Ash 14.735%. This seam has been opened repeatedly east of Barclay, 2½′ to 3′ thick.

Nearly all the Barclay coal is a true semi-bituminous fuel, with relationship of volatile hydro-carbon to fixed carbon, 1 to 4.0939. It is largely used for generating steam on the locomotives of the N. Y., L. E. and W. R. R. and the N. Y., Central R. R. and its connections. The following table of the various benches of bed B at the *Schroeder* and *Barclay mines* conveniently shows the general character of the marketable coal.

	Bed B, Barclay.				Bed B, Schroeder.		Bed A, Fall Creek.
	Upper bench.	Middle bench.	Lower bench.	Average.	Middle bench.	Lower bench.	
Water,	.730	.760	.880	.770	.940	.860	.850
Volatile matter,	17.220	16.405	16.660	17.110	17.845	16.755	16.625
Fixed carbon,	69.840	63.172	73.257	70.744	72.155	69.880	67.292
Sulphur,	.795	.613	.643	.776	.670	.715	.498
Ash,	11.415	20.050	8.560	10.600	8.390	12.800	14.735
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Coke per cent.,	82.05	82.535	82.46	82.12	81.215	83.495	83.525
Color of ash,	Gray.	Gray, yellow tinge.	Gray.	Gray.	Gray, yellow tinge.	Gray, yellow tinge.	Gray.

An average of six analyses of coal from bed B at these two mines gives the following result, which closely indicates the real character of the merchantable coal.

Water,	.822
Volatile matter,	16.999
Fixed carbon,	69.593
Sulphur,	.702
Ash,	11.884

The Blossburg Basin in Tioga County.

This is a canoe shaped synclinal basin, remarkably symmetrical, extending from a point just beyond *Fall Brook*

on the east to and beyond the *Bache mine* on the west side of Wilson creek. General strike is N 19° E and S 19° W. The principal points of development are the *Fall Brook mines*; *Morris run*; *Blossburg*; *Arnot**; *Landrus* and *Antrim*, a distance of about 20 miles, with a width of basin averaging about 3 miles, with all the above named places closely marking the synclinal axis of the basin with the exception of Fall Brook which lies to the south-east.

The drainage streams represent an enormous destruction of coal area; but they have also afforded an easy and economical outlet for nearly all the coal left in the basin. Geographically this *Blossburg basin*† occupies a commanding position for a cheap supply of soft coal to the markets of New York State.

The *Fall Brook Coal Co.* have been mining on a large scale for years in the most eastern part of the Blossburg coal basin and a complete vertical section of the measures, reported by Mr. Hardt, chief engineer, is given in plate 430, fig. 1, together with Mr. Platt's section (fig. 2). The top coal bed, known locally as the "*Seymour* or *Cushing seam*," is given as 2′ 8″ thick, but is not mined for shipment, being rather high in sulphur. The second coal, the "*Morgan* or *Dirty seam*," is of still less importance; but the sandstone between the two beds is one of the most marked and persistent in the Blossburg basin and is known everywhere as the "*Monkey ledge*," 40′ to 60′ thick, current

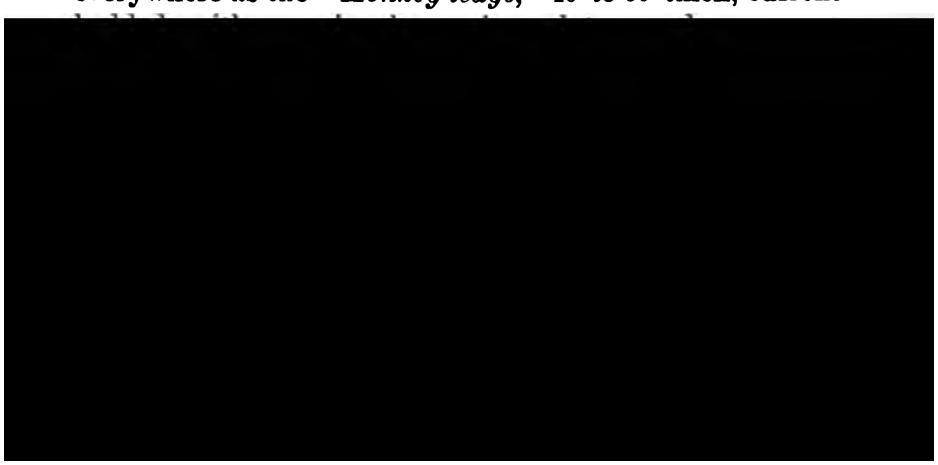
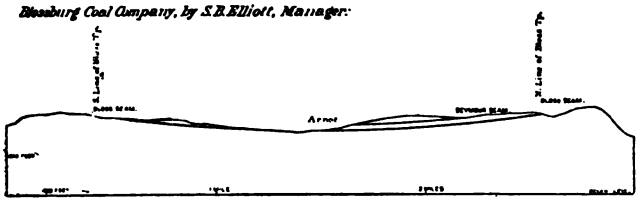


PLATE 431.

No XIII Allegheny Coal Series. Bradford & Tioga Counties

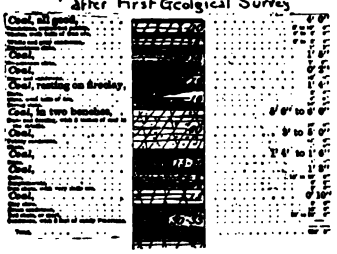
Vertical Sections of the Coal Measures.

Section across the Coal basin at Arnot in Tioga County, looking westward; showing the main or "Bloss Seam" bed B. outcropping at the North Bloss township line, 412' above its outcrop in the centre of the synclinal at Arnot; and showing also bed C lying 154' above the Bloss bed, B. Published by permission, from a drawing made for the Blossburg Coal Company, by S.B. Elliott, Manager:

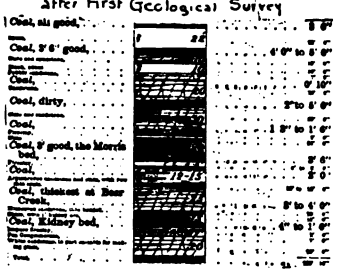


Vertical Sections in Tioga County Pa

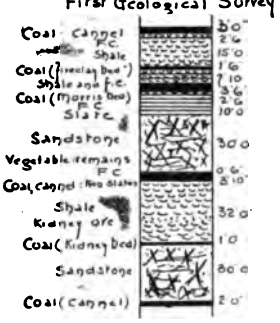
1. Morris Run. Blossburg Basin.
after First Geological Survey



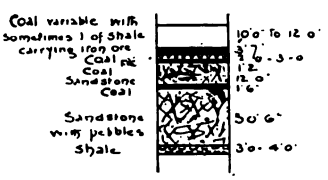
2. Blossburg Section
after First Geological Survey



3 Coal Run Section
First Geological Survey



4 Bear Creek Section
First Geological Survey





and clay to be economically mined in a clean condition for the market. The "*Bloss coal bed,*" usually identified as bed B of the Allegheny series, is the next bed in descending order and by all odds the most important seam of the basin.

Under the name of the "*Blossburg coal*" this fuel has won for itself a most excellent reputation in the markets of New York State and several million tons of it have gone to supply the demands of that region. The bed varies from 3′ 4″ to 5′ in thickness, averaging about 4′ 6″ In places it has no regular parting slate but elsewhere it carries 8″ of that substance in three layers, with usually 6″ of bottom coal under the lower slate. An average specimen from the Fall Brook mines shows this coal to contain about 18½% of volatile matter, 70% of fixed carbon, .661% sulphur and 9.185% ash. The *Bear creek seam* occurs from 20′ to 40′ beneath the Bloss bed and is from 2′ to 3′ thick in places; but it will average more nearly 1½′ in the region generally, and is consequently not a commercial seam, besides containing more ash than the Bloss bed above it.

The *Morris Run mines* are opened three miles east of Blossburg and about 2 miles west of Fall Brook. A vertical section at this point is given on page plates 430 and 431. The *Seymour seam* has been also opend here and is called a 2½′ bed; but as at Fall Brook, Arnot and Antrim it everywhere carries more sulphur than the Bloss coal, averaging about 2%, which renders it doubtfully commercial at the present time. The *Bloss bed* is here at its very best, fully 5′ or more of clean coal, and lying so well for easy mining that a single mine has yielded 1500 tons of coal daily when the demand is active. An average specimen of the coal as shipped to market from this mine yields as follows: Water 1.120%; V. M. 18.570%; F. C. 72.097%; Sulphur .583%; Ash 7.630%. This shows a most excellent steam coal, free from injurious impurities and fully justifying the reputation of these mines after a shipment of several million tons of coal to the general market.

At *Arnot* the *Blossburg Coal Co.* have mines opened 3

miles west of Blossburg, and a very complete and efficient plant. The measures exposed resemble in their main features the sections at Fall Brook, Morris Run aad Blossburg. The *Seymour* and *Bloss beds* are separated by about 135′ of measures, 90′ of which is solid sandstone and the balance slaty sandstone and slate. The Seymour bed has been worked for shipment at Arnot and will average about 2′ 8″ thick, with an analysis reported in G page 179 showing: .907% sulphur and only 4.753% of ash, undoubtedly of higher character than would be yielded in average work. The intermediate coal beds are not opened for shipment and have usually proven themselves as small and valueless. The "monkey ledge" shows the same characteristics here as at Fall Brook. The *Bloss bed* is again the principal coal seam worked for shipment, of excellent character and very regular in average thickness, yielding about 3′ 6″ of clean coal or 5000 tons to the acre. The coal however is divided into benches; the partings are very persistent and recognizable under their change in thickness. The coal separates cleanly from the parting slates except the middle bench which shows a tendency to stick to the bone coal beneath it. An average section shows as follows: coal, top bench 1′ 0″; slate 0′ 1″; coal, middle bench 0′ 8″; bone 0′ 2″; coal, bottom bench 1′ 8″; slate 0′ 1½″; coal "mining" 0′ 8″. The latter is used for bearing in and is therefore destroyed in mining.

Analyses of the three benches are given in Report G page

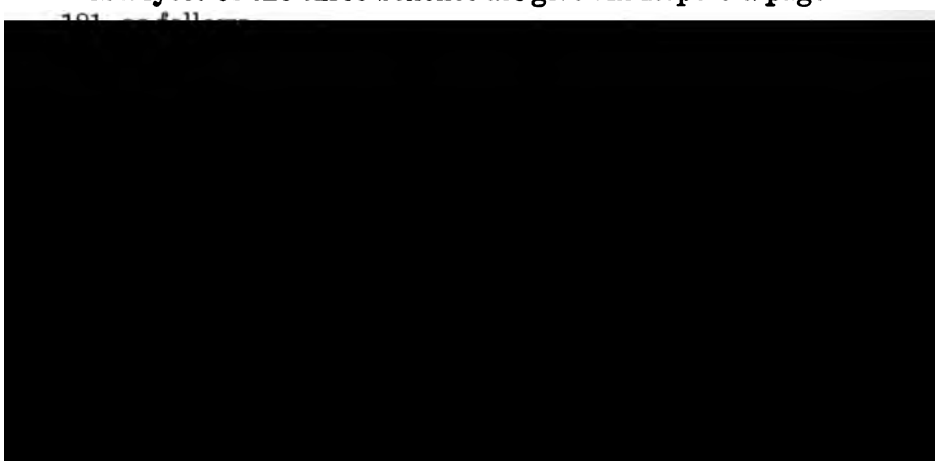
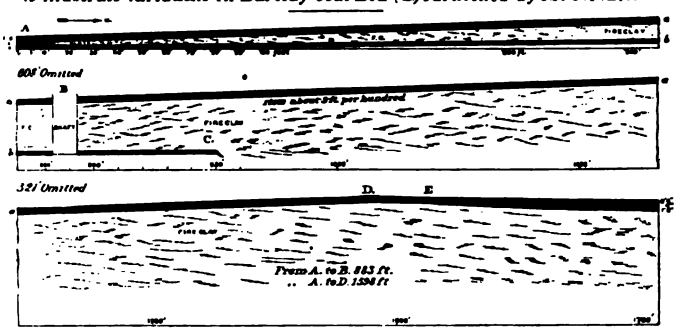


PLATE 432.

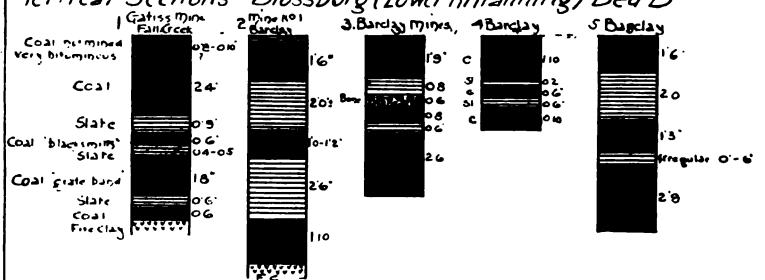
No XIII Allegheny Coal Series Bradford and Tioga Cos

Barclay Coal Basin in Bradford County.

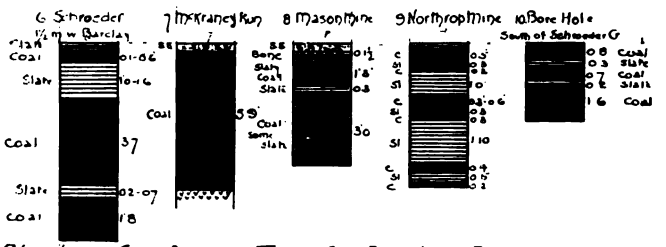
Isolated lengths of longitudinal Section to illustrate Variations in Barclay Coal Bed (B) furnished by Mr F. F. Lyon



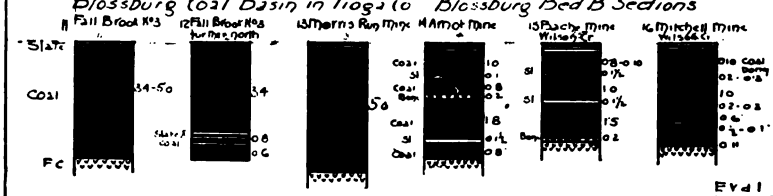
Vertical Sections Blossburg (Lower Kittanning) Bed B



Blossburg Coal Bed



Blossburg Coal Basin in Tioga Co Blossburg Bed B Sections



Eva I



and blacksmith use; but some considerable effort has been made to utilize the slack for coking purposes.

The *Landrus* or *Bear Run mine* of the Blossburg Coal Co. is situated 5 miles west of Arnot close to the line of the Tioga Division of the N. Y., L. E. & W. R. R. The Bloss bed is worked here, and Mr. Dobson supt. writes that it is cleaner than at Arnot, and free from the 1½″–2″ sulphur band in top bench that the Arnot mine section carries. There is however a sulphur shale below the middle bench, the section being: shaly s. s. roof; coal 1′ 5″; slate 0′ 9″; coal 1′ 4″; sulphurous slate 0′ 2″; coal 0′ 6″; fire clay. The bottom coal in places is 9″ thick and sometimes disappears altogether. The whole bed is undulating and irregular; but the coal is good and is mined to the extent of over 600 tons daily.

The *Antrim mines* of the Fall Brook Coal Co. are situated 8 miles west of Arnot and west of the deep valley of Babb's creek. A vertical section of the measures exposed here is given on plate 430 fig. 5. It shows striking differences as compared with Morris Run, Arnot and Fall Brook. Some coal beds are wanting; rock intervals are different in character and intervals much changed. As elsewhere in the general basin the *Bloss bed* furnishes all the merchantable coal at this plant, although the *Seymour bed* is stated to be 5′ 6″ thick with however a damaging percentage of over 2.8% of sulphur. The Bloss bed is 5′ 4″ thick although of course running down very considerably in various parts of the workings. It proved however to be as reliable and as persistent in size and character as at other places in the basin, showing .548% of sulphur and 5.105% of ash, with every requisite for a valuable steam fuel.

On Wilson creek, west of Antrim, the Bloss bed has been opened in a number of places 30′ to 40′ higher in elevation than at Antrim, and has been mined for local use for some years. In 1877 the region was almost entirely undeveloped with the exception of these few country pits, the basin spooning out about two miles west of the Bache mine. At the latter point the bed still shows a triple sec-

tion from 3½′ to 4′ thick, carrying thin slate partings. Some of the coal breaks up into hard blocks: again it is much softer in physical structure; but both varieties show an excellent chemical composition, carrying about one-half of one per cent. of sulphur and 7% of ash.

At the *Mitchell mine*, one mile west and nearly opposite the Antrim mines on the west side of Wilson creek, the bed again shows bright and compact, with much mineral charcoal but still carrying the same characteristics, with a top bench somewhat intermixed with bone, yielding about 10% of ash. The coal in this part of the basin is fully equal to the average character of the bed as mined in the larger openings and also holds its average thickness well. The *Bear Creek seam* has also been found 2′ thick at 19′ below the Bloss bed at the Mitchell mine. (See plate 432 fig. 16.)

The *Lower Productive Coal Measures** can still be followed by patches left on the hill tops south-west on either side of the Babb's Creek valley to the Lycoming Co. line; but at few if any of these places is there much merchantable coal remaining. The Conglomerate rock beneath the Bear Creek coal sweeps around the basin in a well defined line, and when the Bloss bed comes to day-light on the north outcrop of the basin, it shows its full size, but the coal is friable, soft and columnar.

Under the generic name of "*Blossburg Coal*" it is as

1.465%, volatile matter 19.471%, fixed carbon 68.974%, sulphur .686%, ash 9.134%.

The Gaines Basin in Tioga Co. and Pine Ck. in Potter Co.*

This small coal basin occupies a limited area in the central parts of Tioga and Potter Cos., some 15 or 20 miles to the north-west of the Blossburg basin. Although its synclinal axis extends completely across Tioga Co., filled with the conglomerate measures, only a very limited portion of it in Gaines twp. is geologically deep enough to contain the *Lower Productive Coal Measures* (plate 428).

In 1877 this region was but sparingly developed; but in the center of the basin, where the highest geological measures are caught, a thin bedded sandstone usually much current bedded, 35′ thick, makes the hill crest. Under it occurs the "*Hurd Coal Bed*", reported 22″ thick and 20 lower than the *Knox and Billings coal*, mined about 2 miles from Gaines P. O. It has no regular and persistent slate parting, but some irregular small lenticular masses of slate show in the bed. The average thickness of clean coal is about 3′ increasing slightly in some parts of the mine. The coal is screened at the mine and is largely used for smithing purposes, showing about .8% of sulphur and 7½% of ash, but with largely increased percentage of volatile matter over the Bloss bed, amounting to 28%. This is considered the most valuable and persistent bed in the basin although it is subject to considerable variations in thickness.*

[No. XIII in Potter County.†

Four or five synclinal basins which cross the county in a north-east and south-west direction contain patches of the

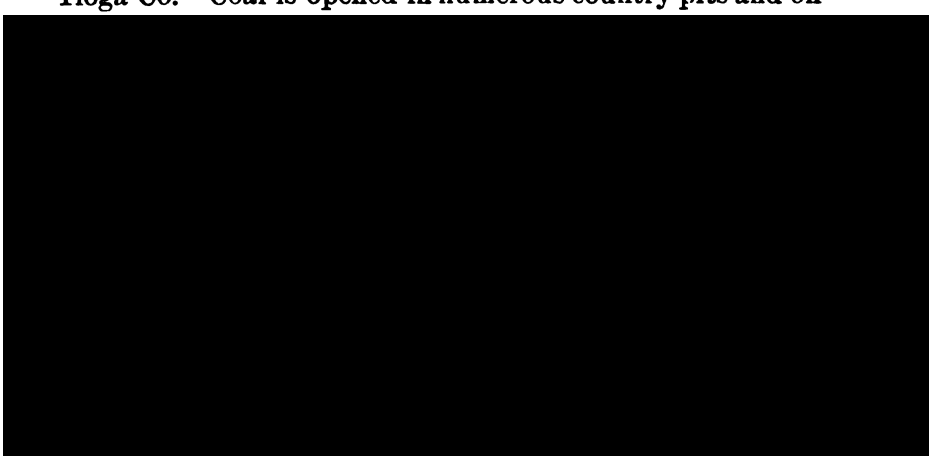
*Mr. Sanderson Smith reports having found 8 different coal beds in this basin all of which are referred to in report G pages 224 and 225; but only the *Knox and Billings bed* seems to be of workable thickness. A vertical section showing sequence of the measures as reported by Mr. Sherwood (report G page 226) confirms this statement. The general limits of the coal are from Assaph's run on the east to Long run on the west.

†Report G3. Surveyed by J. P. Lesley in 1841; H. D. Rogers in 1846 and F. Platt in 1879.

Lower Productive Coal measures, all very much scattered and of inferior commercial importance. The *Blossburg basin* only occupies the extreme south-east corner of the county and holds but little if any of the coal measures.

The *Kettle Creek* or *Oleona basin* is a shallow dimple occurring midway between the Blossburg and Gaines coal basin of Tioga Co., which spoons out north-eastward just beyond the limits of Potter Co. The erosion of the coal measures in this basin has been enormous, and it is somewhat remarkable that a coal bed has been opened for the local supply of Germania and vicinity, in a round knob only a few acres in extent on the very top of the mountain crest. None of the other small patches left in the hill summits in the center of this basin between ravines made by the branches of Kettle creek are of commercial importance or accessible to present railroad facilities.

The *Mill Creek-Pine Creek basin* (a prolongation north-eastward of the Third basin) is the third synclinal going north in this county and is more or less connected geologically with the Cowanesque basin by reason of the conglomerate and portions of the coal measures, in broken patches, spreading over the depressed Chatham anticlinal separating the two. The coal producing part of the Pine creek basin lies north of the west branch of Pine creek and is a direct prolongation of the *Gaines coal basin* of Tioga Co. Coal is opened in numerous country pits and on



north the center of the syclinal is largely occupied by subcarboniferous rocks with some few patches only of the *Conglomerate of XII;* and while some few individual deposits of coal have been reported, it is largely barren. The completion of the Buffalo and Susquehanna R. R. now gives this field an outlet on the south to Williamsport and to the north-west to New York State and Canada. The most striking comparison between the coal from this basin and the Blossburg basin is the increase of fully 10% in volatile matter, making it a gas coal as well as a steam fuel, although its increased percentage of both sulphur and ash would militate somewhat against its use for the former purpose.

The *Coudersport basin*, next north, has a well defined canoe shape, holding in the center of its deepest part a portion of the *Pottsville Conglomerate No. XII;* and it is quite possible that the two small patches in the vicinity of Coudersport, on opposite side of the Allegheny river, may contain a thin cover of the Lower Productive coal measures. The gray massive sandstone layers beneath the coal, measure 60′ or 70′ in all; contain a good deal of conglomerate and are presumably the bottom member of the *Pottsville Conglomerate No. XII*, identical with the *Shinersville conglomerate* of Sullivan Co. and the *Olean conglomerate* of McKean Co. About 50′ of measures, possibly the middle membes of XII, overlie the massive rocks just described, and about 15′ above the base is a coal bed 16″ or over, opened on the west side of Nelson run. It probably lies within the conglomerate. There is another coal some 50′ above this bed, which is always found very small and underlies a limited area in the center of the basin.

No XIII in McKean County.

The *Lower Productive Measures* in this county are so thin (140′) and so devoid of commercial value, that they have been treated in connection with the *Conglomerate Series No. XII* (see Chapter CXVII of this report; pages 1873 to 1880.)

The *Clermont* (Clarion A') and *Dagus* (Lower Kittanning B) beds are the only two members of the *Allegheny River Coal Series* in the entire county; and only the Clermont bed has been mined. The general section of this group shows:

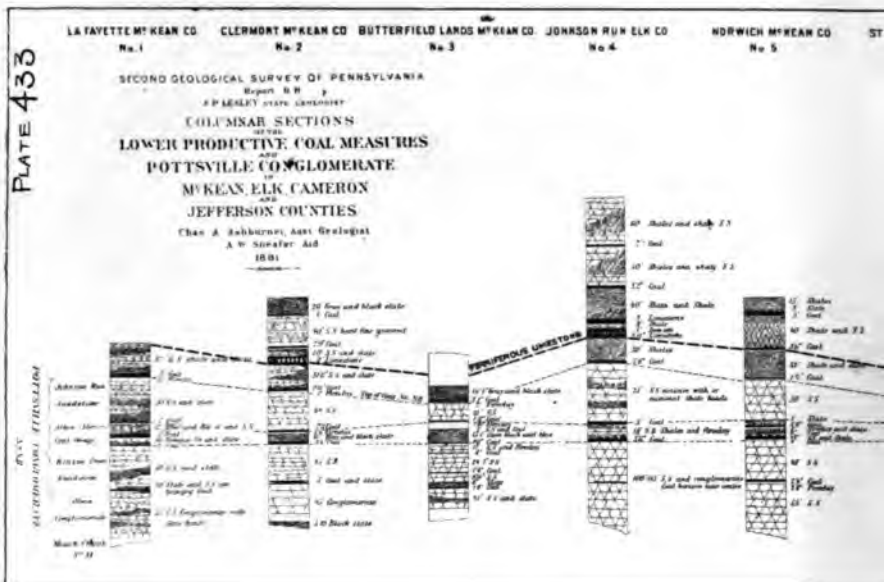
1.	Gray and black slate,	20′
2.	*Coal*,	1′
3.	Gray and brown sandstone,	40
4.	*Dagus coal* (Bed B),	2′ 9″
5.	Fireclay,	2′
6.	Sandstone and slate,	8′ to 30′
7.	Clermont (Ferriferous) sandstone,	4′ to 8′
8.	Sandstone and slate,	30′
9.	*Clermont coal* (Bed A'),	3′
10.	Fireclay,	3′
	Johnson Run Sandstone; top of Conglomerate No. XII.	

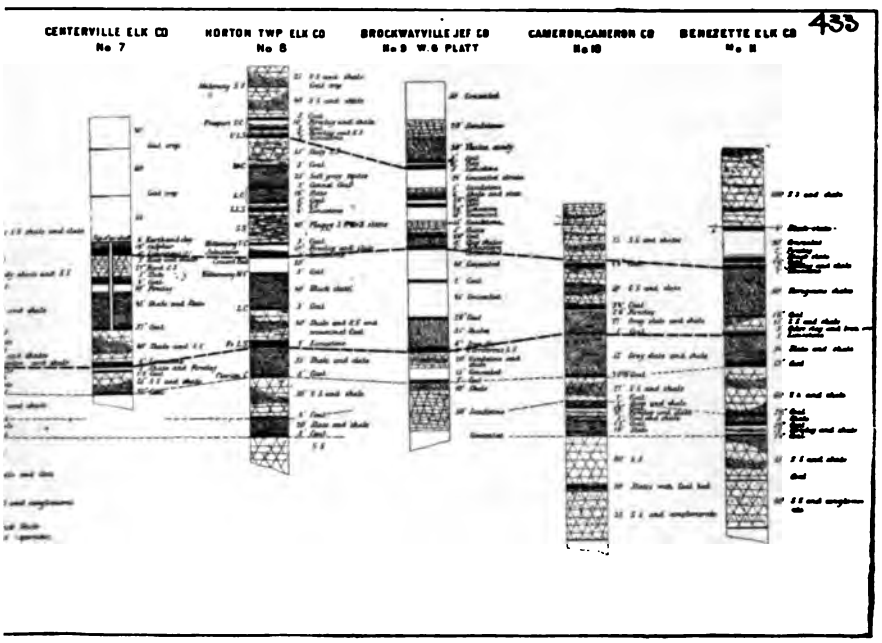
Of the *Dagus coal* there are only 40 to 50 acres in the Clermont basin, ranging from 2½′ to 3′. In the Norwich basin it is opened at the Coal-pit mine. It is absent in the Alton basin.

The *Clermont coal* has its largest area in the *Fourth* and *Fifth basins*, and has been mostly mined by the *Buffalo Coal Co.*, immediately opposite Clermont station. It has also been worked at Buttsville, in the Davis hill, Lafayette, and at several localities on the Lafayette plateau between Lafayette and Big Shanty. Though its area is small it is the most important bed proved in McKean Co.

In Norwich twp., at the head of Indian run, it is reported 4′ thick; in the Clermont basin of Sergeant twp. 2′ 4″ to 3′

PLATE 433


LA FAYETTE Mc KEAN CO.
No. 1
CLERMONT Mc KEAN CO
No. 2
BUTTERFIELD LANDS Mc KEAN CO.
No. 3
JOHNSON RUN ELK CO
No. 4
NORWICH Mc KEAN CO
No. 5
SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA
COLUMNAR SECTIONS
OF THE
LOWER PRODUCTIVE COAL MEASURES
AND
POTTSVILLE CONGLOMERATE
IN
Mc KEAN, ELK, CAMERON
AND
JEFFERSON COUNTIES
Chas A. Ashburner, Asst Geologist
A. W. Sheafer Aid
1881
FERRUFEROUS LIMESTONE


CENTERVILLE ELK CO
No 7
NORTON TWP ELK CO
No 8
BROCKWAYVILLE JEF CO
No 9 W.6 PLATY
CAMERON,CAMERON CO
No 10
BENEZETTE ELK CO
No 11



been doubtfully recognized at the Deer Lick opening on the summit between Long brook and Warner brook, in two benches 3′ 2″ and 1′ 6″, separated by clay and shale 1′ 6″. In Davis hill, Lafayette twp., the bed generally occurs in one solid bench 3½′ to 5′ thick, with occasionally a thin binder near top; but it is subject to many local variations. In the *Davis mine* it averages 5′, slate roof and fire clay floor; but it is only 2′ in a drill hole north-east of Lafayette village. Again on the Newell farm it rises to 5′, whereas in the Kane district of Wetmore, it is rarely over 2′. Hence each separate locality must be tested independently to ascertain the real character of this coal bed.

*No. XIII in Cameron, Elk and Forest Counties.**

The general results of several years of patient work in this unstudied field seem to point to the conclusion that the coal beds which can be profitably mined are confined to Elk and Cameron Co.'s, the former county containing more coal beds, better coal beds, and beds underlying greater areas than the latter; and that there were excellent reasons for attaching considerable economic value to the *Toby creek* and *Shawmut coal basins*, not formerly considered of much mining value,—a suggestion which, so far at least as the *Shawmut basin* is concerned, has proven substantially correct and of great importance to the region.

The numerous coal outcrops in Forest Co. did not then nor do not now hold out much encouragement for the establishment of a successful coal industry in competition with the more highly favored fields to the east and south.

*These three counties form one general report R 2, the field work for which was begun during 1879 but suspended for several years upon the transfer of Mr. Ashburner to the Anthracite district, when he was replaced to a large extent by Mr. A. W. Sheafer, to whose patient care and skill much of the excellent detailed work in this district is due. The report is accompanied by an atlas containing three geologically colored maps of the three counties as well as a number of other valuable charts and plates, not the least valuable of which is one containg a series of 11 vertical sections of the *Lower Productive Coal Measures* and the *Pottsville Conglomerate* in McKean, Elk, Cameron and Jefferson Co.'s, from which a clear insight can be gained of the variation and extent of these groups in the several fields. (See plate 433 of this report).

In Cameron Co., the *Productive Coal Measures* are largely confined to the *Cameron coal basin*, equivalent to the *Caledonia basin* of Elk and the *Wharton basin* of Potter, the whole forming the *Third Bituminous Coal Basin*, lying immediately west of the Driftwood or Second Anticlinal axis of Clearfield Co.

The whole basin measured from the Second to the Third axis is about 14 miles in width; but the area occupied by the coal measures, including the *Alton group* in the Conglomerate, is confined to a narrow strip of less than 2 miles wide on each side of the synclinal axis. To the north-east of the Sinnemahoning creek the coal measures underlie only the highest summits; but the basin gradually deepens going south-west into Elk Co.

The coal bearing strata extend from the bottom of the *Conglomerate* up to and including 200′ of the *Lower Productive Coal Measures;* and the principal developments in the basin have been made on lands of the *Cameron Coal Co.*, between the Sinnemahoning and the east branch of Sterling run. Several sections are given in page plate 434, and a general section shows the *Dagus coal,** 3′ thick near the top, which has been generally identified as the *Lower Kittanning coal bed B* of the Allegheny mountains. This coal is mined extensively in Elk Co., at the Tannerdale and St. Mary's mines; at the Cascade mine and at the extensive workings of the North Western Mining and Exchange Co., near Centerville.

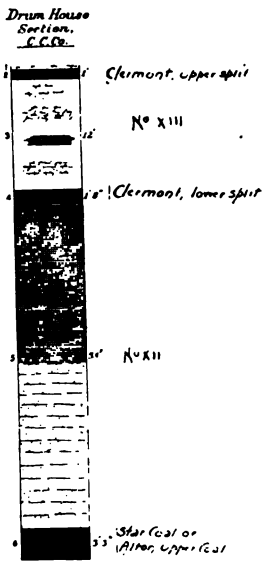


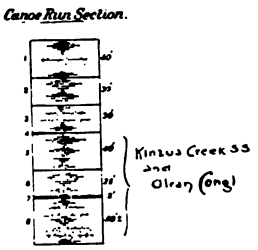
PLATE 434.

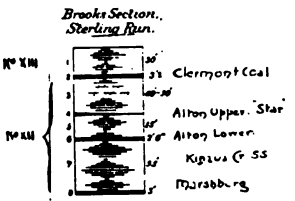
No XIII. Allegheny Coal Series. Cameron and Elk Counties

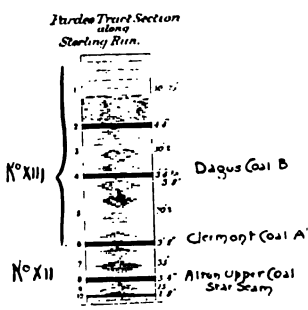
Vertical Sections in Cameron-Caledonia Basin Cameron Co.

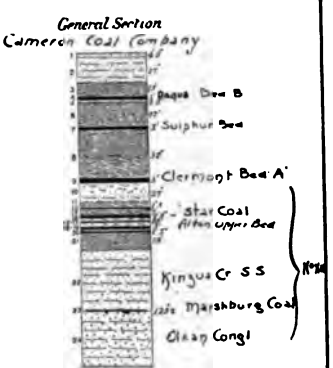
Showing relation between the Low Productive and Conglomerate Series.













a good deal of sulphur. It was also opened at the Patterson mine, on Canoe run, 86′ below the Dagus, 3′ 4″ thick.

Sterling run and its branches contain the greatest area of the coal measures in the county and numerous openings were made on the *Pardee lands* in this locality, a general section of which, on Mill branch of Sterling run, is given in page plate 434.

The *Dagus bed* is opened by two drifts 250′ apart, one-half mile northwest of the mill, showing respectively 3′ 4″ and 3′ 8″ thick, in one solid bench and differing from the underlying Clermont coal in having a red ash, containing less gas and in the character of its fracture. The *Clermont coal* was developed at the Creek opening, showing two benches 6″ and 3′ 1″ thick, with a 1″ sulphur band between them. This was considered the best coal for stove and grate use opened on the Pardee tract.

In Elk Co. the *Cameron–Caledonia basin* is continued directly southwest across Hicks branch into Benezette and Jay townships, roughly parallel to Bennetts branch of the Sinnemahoning, which it closely approaches at Caledonia and Weedsville. Sections in the *Caledonia basin* are given in plate 435, which show the entire group of the *Lower Productive Coal Measures* to be present, overlaid by 100′ of the Mahoning sandstone, although the Freeport coals seem to be wanting. The Upper and Lower Kittanning beds have been found, but they are generally thin and unimportant as compared with the Clermont (Clarion) bed and Alton coals of the *Conglomerate Series.*

North of Benezette, on the waters of Slide run, the Clermont and Lower Kittanning beds, as shown in section page plate 435, have assigned respectively a thickness of 4′ 6″ and 4′ 2″; but it is doubtful whether they maintain such sections over a wide area. Along the road running northeast from Benezette on the divide between the headwaters of Dents run a number of coal openings have been made, and the *Ferriferous limestone* underneath the Lower Kittanning coal has been found 5′ to 10′ thick and largely quarried.

The *Clermont coal bed* was located east of Mr. George Winslow's house, showing three benches 1′ 8″, 2′ 0″ and 0′ 6″ thick, separated by slates 10″ and 2″, which is a rather unusual section for this coal. The *Clarion bed* has been mined at the Brown drift 4′ thick, and again on Murray's farm 4′ 4″ thick, furnishing a coal which has given satisfaction as a good stove and grate fuel, but not suitable for blacksmiths' use. On Overturf's farm the bed shows 4′ 2″ thick and of excellent quality, as is most of the coal mined from this Clarion bed in this vicinity.

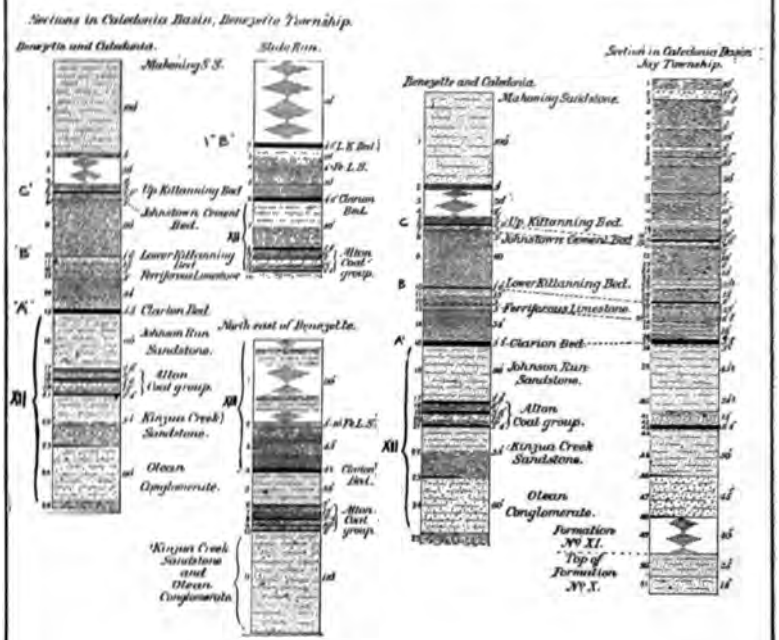
In Jay twp., in the center of the basin, there are 290′ of coal measures overlying the Johnson Run sandstone. The "Big Bed", which is found in Caledonia run immediately below A. E. Goff's place, is the representative of the Clarion bed*, 5′ 3″. A compiled section is very similar to that given for Benezette twp. as may be seen on page plate 435. The largest coal area lies between Spring creek, Kersey run and Bennette branch, which form locally the *Caledonia basin.* Again the Clarion and Alton coal beds, which were found to be the thickest and to contain the best coal in Benezette twp., are the most important here, the Freeport group being generally absent. These two beds are alone relied upon to produce merchantable fuel in this locality. The Ferriferous limestone, forming the best guide to the identity of the coal beds, shows in this run 2′ 2″ thick.

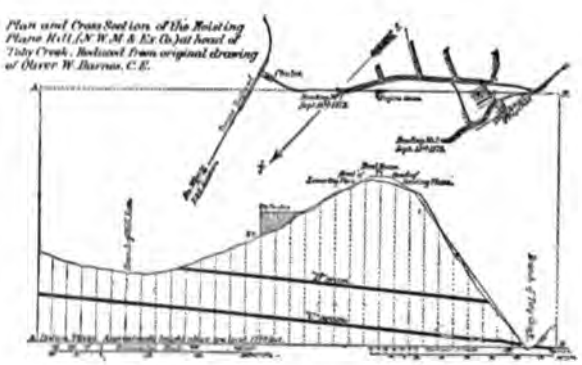
A number of other openings are reported in the geology

PLATE 435

No XIII Allegheny Coal Series in Cameron and Elk Counties

Vertical Sections in Cameron-Caledonia Basin, Elk Co.







Benzinger, Horton and Fox townships, Elk County.

These three townships hold about all the commercial coal found in the *Fourth Bituminous basin* of Elk Co., comprising the local synclinals known as the *St. Mary's basin;* the *Toby basin* and the *Shawmut basin**, all minor folds in the one great trough (see plate 436).

The principal developments in this field have hitherto been made on the property of the North Western Mining and Exchange Co. at their Daguscahonda mines at the head of Little Toby creek; but the more recent developments in the Shawmut basin along Meade and Oyster runs in Horton twp., in the formerly neglected and condemned Shawmut basin, fairly excel in importance all other parts of this basin.

The *St. Mary's coal basin* has the form of a flat canoe rather than that of a trough, with its northern end lifted so that the central line would dip downward at every point. The total thickness of the coal measures and the Pottsville conglomerate group in this basin aggregate 400′, with the Upper Kittanning coal bed C′ forming the highest seam in the section, 90′ vertically over the top of the Dagus or Lower Kittanning bed B in the St. Mary's mine.

The *Lower Productive Measures* proper are detailed in section on page plate 437, showing 235′ thick, and contain only one bed which has proved workable to any great extent, the *Dagus* or *Lower Kittanning coal*, which was likewise the only bed mined in Elk Co. in 1885, prior to the development of the Freeport coals in the Shawmut basin. The Clermont or Clarion coal was mined to a limited extent, but has never proved a desirable bed.

The Freeport sandstone is found in the top of Patton Hill at St. Mary's; but the limestone and *Lower Freeport coal D* have never been discovered and their total absence

*In 1885, when the Elk Co. report was put to press, there were no commercial mines in the Shawmut basin at all; so that the entire development at this place has occurred within the last decade, and is therefor not referred to in that report.

points either to a disappearance of these beds to the northeast or their presence with an extremely thin section, with a considerable thickening of the Freeport sandstone. The *Upper Kittanning coal C'* is said to have been cut in a well near Patton's house, 3' thick ; but this is the only place in Benzinger twp. that it occurs, and the Johnstown cement bed is likewise absent though quite prominent in Horton and Fox twps. to the south-west. The *Middle Kittanning coal C* occurs upon the Cascade Mining Co's. tract; but only 1' 6" thick.

The *Dagus* or *Lower Kittanning bed* has been mined at the St. Mary's Coal Co. Cascade mines, Tannerdale and Keystone mines and has been opened and tested on a number of other properties with an average thickness of about 3'.* As mined by the *St. Mary's Coal Co.* on the Philadelphia & Erie R. R. the bed has a minimum thickness of 2' 10" and a maximum of 3' 6". The roof rocks are very ferruginous, and the filtering water, carrying the iron salts in solution, are thought to be largely responsible for the rusty and dirty appearance of the coal seam at this point, especially as the greatest amount of cover is only 40' and poor. The *Tannerdale mine* shows quite similar characteristics, the coal being 2' 10" thick and showing on analysis 2% of sulphur and 5.785% of ash. This is about its character at the *Keystone mines*, whilst at the *Cascade mines* east of St. Mary's the coal averages 3' 4" thick and frequently rises to 4' in height. It however contains as great

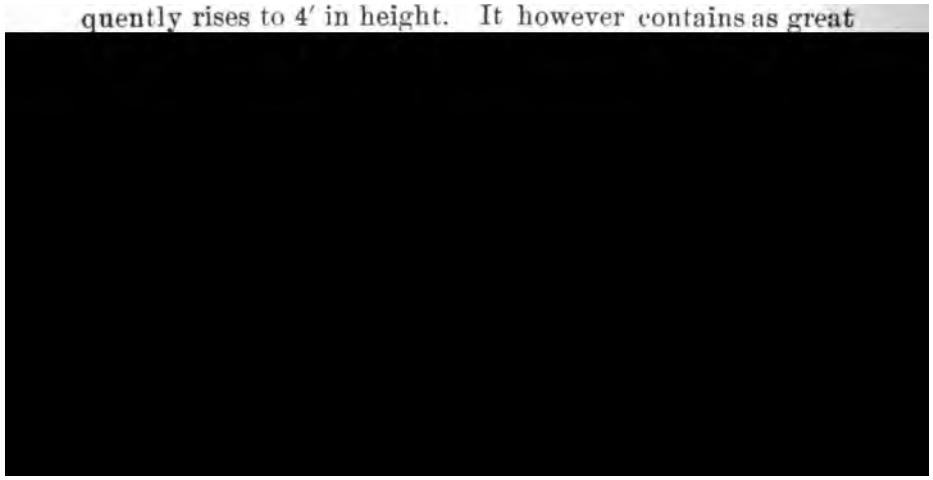
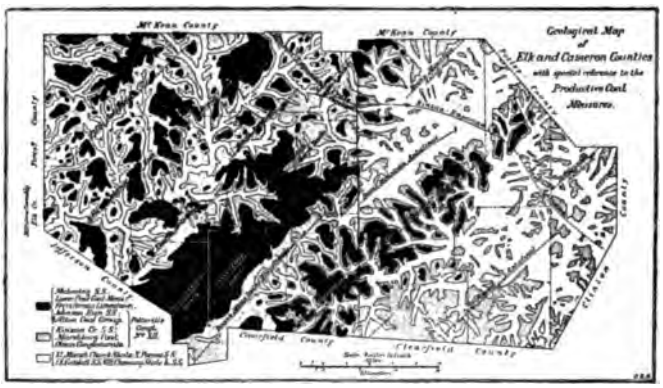
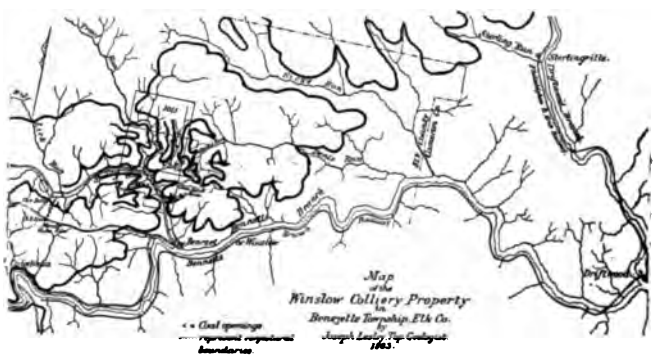
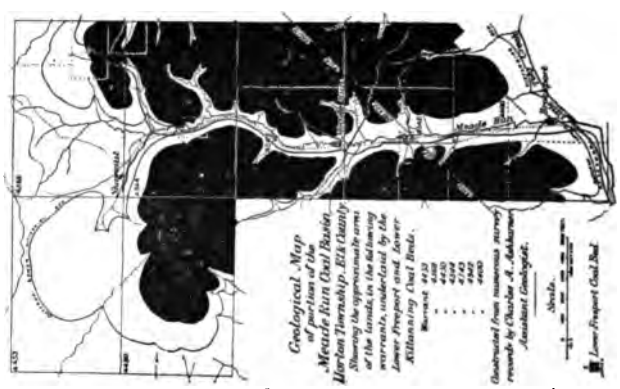


PLATE 436.

No XIII. Allegheny Coal Series Cameron and Elk Counties









explored from the base of the Olean conglomerate to some distance above the Dagus coal. The Clermont coal does not show over 2′ thick and even the Dagus bed has never been found of workable quality and dimensions on this tract. The *Clermont bed* is the most important in the valley of Silver creek, and this is the only locality in the county where it has been mined. Its analysis given in report R 2 page 170 was very favorable, as follows: F. C. 52.657%; V. M. 57.890%; sulphur .838%, and ash 7.745%. The bed became so much reduced in thickness however that mining was generally suspended in 1879.

The natural wealth of coal in Fox twp. lies within the watershed of Toby creek and its branches, except a very small area in the northern part drained by branches of Elk creek.

The *Toby* and *Shawmut coal basins*, like the St. Mary's basin already described, may possibly be closed or canoe shaped troughs with the southwestern end of the latter passing the northeasterly end of the former. The coal beds, with the low dips which they possess in the Toby Creek valley, seem to lie in almost horizontal positions when exposed over a very small area; but when the actual dip is measured it is found to be considerable, ranging from 50′ to 200′ per mile. Vertical sections of the measures in Fox twp. are give in page plate 437, that at *Centreville* and the *Dagus mines* being the most satisfactory and general.*

The *Dagus* or *Lower Kittanning bed* has furnished all the valuable coal in the township and has been extensively worked for many years in the vicinity of Earley and Centerville as the principal source of supply for the shipments of the North Western Mining and Exchange Co. It varies from 3′ to 4′ thick and is generally found 30′ to 50′ above the Clermont (Ferriferous) limestone and from 50′ to 70′ beneath the Middle Kittanning coal.

A characteristic section of the bed will not vary much from 3′ in one bench. It has also been worked at the *King mine*, as well as at numerous other places along branches of

*The Lower Productive and Barren Measures comprise about 350′ of this section.

Toby creek. In the *Dagus mines* it averaged for a long time 3′ 7″, with a maximum of 3′ 10″ and a minimum of 2′ 11″. The top of the coal is sometimes sulphurous and occasionally a little bone is found. As compared with other sections* of the Bituminous coal fields of the northern part of the State, local squeezes and faulty coal in the Dagus mine are comparatively rare, and local dips here are fewer than might be expected.

The *Shawmut basin* in Horton twp., while virtually an integral part of the general *Fourth Basin*, is deflected westward along the Horton-Fox twp. line, so that instead of following the topographical basin of Toby creek, its axis line lies from 1½ to 2 miles to the west. Consequently the area which is underlaid by the *Productive Coal Measures* is far greater than is usually credited to this township, and this, together with the fact the *Meade Run* or *Shawmut basin* is a comparatively deep synclinal along its axis, makes Horton the leading township so far as the amount of coal which it contains is concerned. (See plate 436.)

The failures attending the operations of the old *Shawmut Coal Co.* were due to the fact that the two lowest workable beds in the series (the *Lower Kittaning* and *Clarion*) were opened on the western rim of the basin, in the worst locality which could have been selected for a profitable mining operation. The *Lower Freeport coal*, which has been lately developed and shown to contain some of the best coal shipped to the north-western and Lake markets,

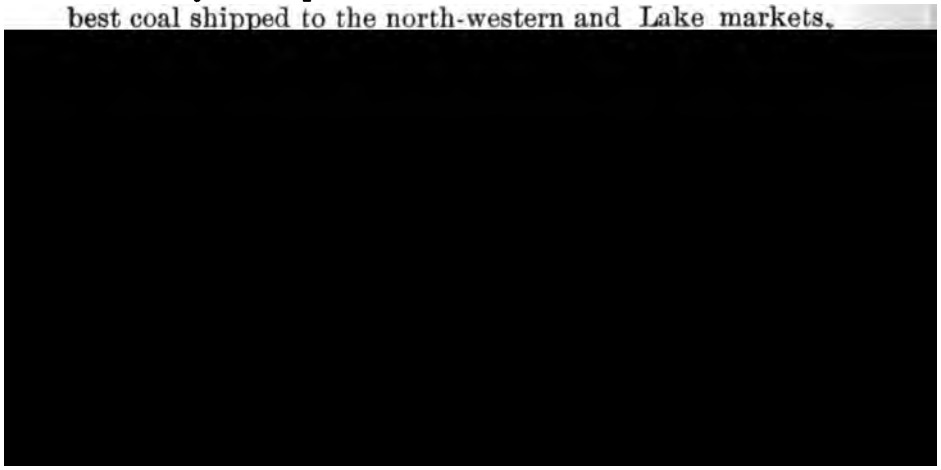
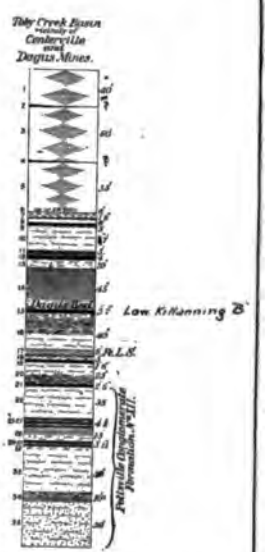


PLATE 437.

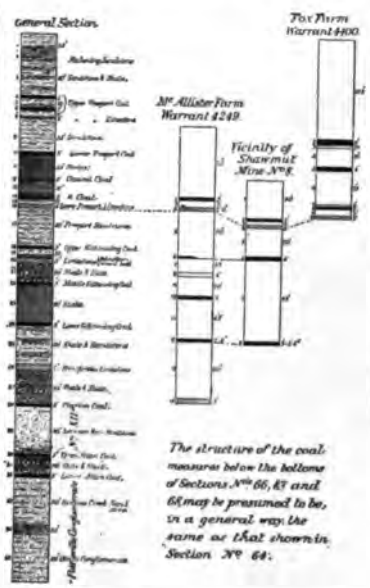
No XIII. Allegheny Coal Series Cameron and Elk Counties

Ver. Sections in Fourth Basin Elk Co



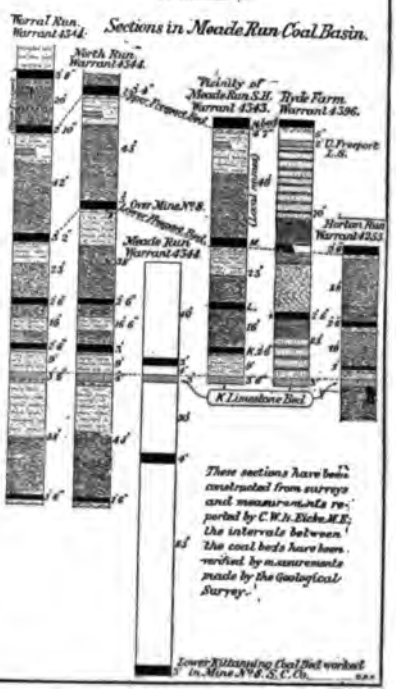


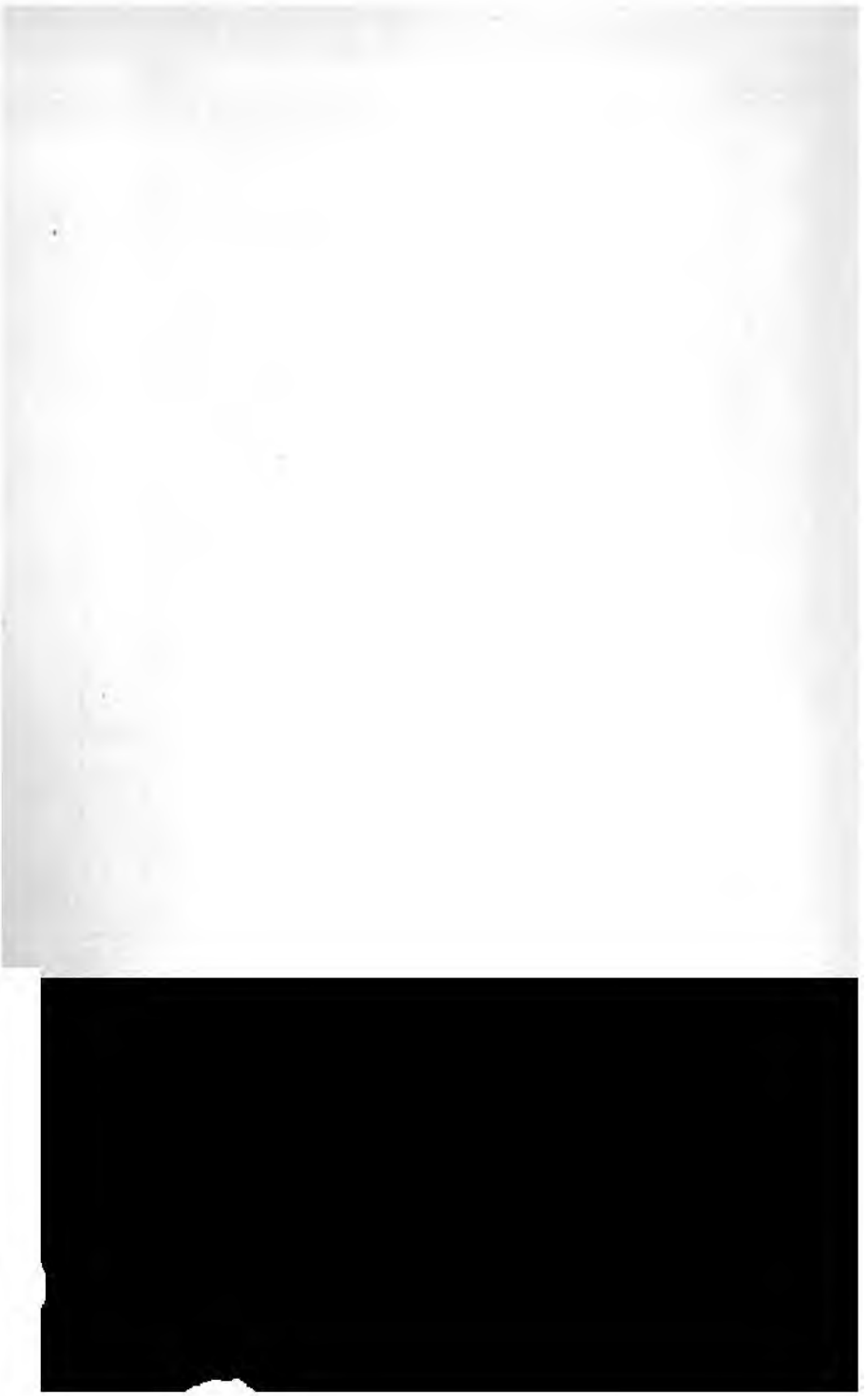
Sections in Meade Run Coal Basin.



The structure of the coal measures below the bottoms of Sections Nos 66, 67 and 68 may be presumed to be, in a general way the same as that shown in Section No 64.

Sections in Meade Run Coal Basin.





The *Lower Productive Coal Measures*, including the Mahoning sandstone, have a thickness in this basin of 392′ and the Pottsville Conglomerate series 185′. (See section plate 437.) This section exhibits the relative positions of the different coal beds in the *Meade Run coal basin* and for the first time correlated the various lettered beds in Elk Co. with the generally adopted system of names employed in the Allegheny Mt. region.

The *Mahoning sandstone* is the uppermost formation in the basin and consists of a gray and yellowish flaggy sandstone and shale 100′ thick. The *Upper Freeport coal E* is frequently composed of three distinct beds, separated by a stratum of fire clay or shale 6′ to 12′ thick. An excellent series of vertical sections of the coal group in various parts of this basin are shown in page plate 437, which clearly portray the characteristics of the group.

The average thickness of each of the two benches of the Upper Freeport coal is placed at about 3′, although when the report was made very few openings could be inspected. On Coal run this bed apparently exists as one solid bench of coal, reported 6′. The Freeport upper limestone underlies this coal 5′ to 10′.

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mines, which have a capacity of 2000 tons daily. It also owns the *Noble Coal Co's.* property on Brandy Camp run, adjoining the old Shawnut property, yielding about 300 tons daily. Also the *Kersey Coal Co's.* property, 2 miles west of Centreville and operate the Paine Mines near that place.

The present *Shawmut* and *Meade Run mines* are located about 2¼ miles south of the original mines and operate the *Lower Freeport coal D*, here 130′ higher than Bed B, the seam once worked at No. 8.

In a recent letter from the Supt. Mr. George Mellinger he states that "the coal is an excellent steam coal, 3′ to 4′ 6″ thick, entirely free from partings and when properly mined, yields a large percentage of lump coal, bearing transportation well. The roof is sometimes slate, sometimes sandstone, but never troublesome. The bottom is fire clay 2′ to 3′ thick, which is being mined and manufactured into pressed brick for building purposes, burning into a good buff brick. Both the lower and upper Kittanning beds show 3′ thick, and the Johnstown Cement limestone bed is 8′ to 10′ thick."

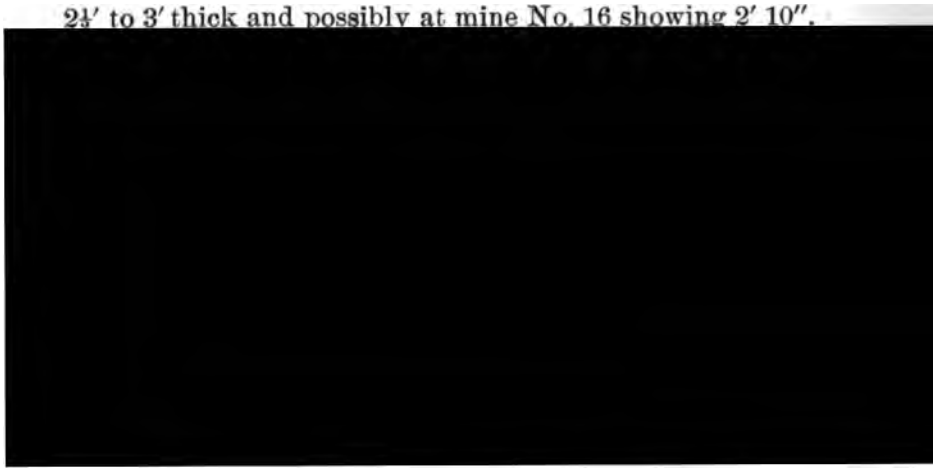
In connection with these several mines, this corporation operates the St. Mary's and South-Western R. R. between St. Mary's on the Philada. & Erie R. R. and Shawmut. The successful development of this territory is of great interest and fully endorses the work of the Survey, inasmuch as the failure of the original Shawmut Co. had convinced everyone that no commercial coal could be found there.

The *Lower Freeport coal D* (locally called the "M" vein) has been proven to hold a thickness of from 3′ to 5′ along Meade, Oyster and Johnson runs and their branches, and is by all odds the most important and valuable bed in Elk Co. Topographical conditions also favor its cheap mining, so that the success attending its development in recent years is not surprising. It carries a very low percentage of ash and sulphur and furnishes a strictly first class steam coal. It is identical with the great D bed of the Reynoldsville and Punxsuatawney regions in Jefferson Co.; the famous Moshannon bed of Clearfield Co. and the Allegheny Mt. district.

The great thickness of strata between the coal and limestone in this basin (50′ to 60′) is exceptional and the occurrence of two thin coal beds in this interval, one of them being sometimes workable, is not surprising. The Kittanning group, extending from the Ferriferous limestone up to the Freeport limestone, has an average thickness of 124′ and contains three coal beds, each averaging 3′ thick.

The *Kittanning lower coal* or *Dagus bed B* underlies a very large area of this basin and was thoroughly developed at mine No. 8 of the old Shawmut Co., where the bed varies from 3′ to 3½′ thick. It passes under water level at this point and does not outcrop again along Meade run until near its mouth.

The *Clarion coal bed* was mined at No. 7, showing from 2½′ to 3′ thick and possibly at mine No. 16 showing 2′ 10″.



locally known as the *Johnson Run synclinal* and is the *Clermont basin* of McKean Co.

In Jones twp. the greatest thickness of the coal measures is found immediately underlying the summit of Pistner Hill, where they are about 200′ thick and the conglomerate 220′ thick.

The coal measures in this basin in Jones twp. are characterized by greater variations, both as to thickness and character, than has been found elsewhere in the district, and this has led to much confusion in their stratigraphical relations. The two principal coal areas are what have been variously called Johnson Run, Kane's, Clay's or the McKean-Elk Land and Improvement Co.'s basin, lying between the branches of East and West Clarion creeks; and the Silver Creek, Bear Creek or Schultz basin, lying southwest of the West Clarion and between Bridgetown and Highland settlements.

The general section in the first district is given on plate 438, compiled in the vicinity of the *Bucktail mines.* The highest coal, 60′ below the hill top, has been regarded as the *Middle Kittanning bed*, 2′ thick, and 50′ lower is the *Lower Kittanning* or *Dagus bed*, 3′ 2″ thick. The Ferriferous limestone creates a well marked horizon 52′ lower in the measures, and 7′ 11″ thick, forming a valuable key rock for the identity of the coal measures. The *Lower Kittanning coal* has been mined by the North Western Mining and Exchange Co., at their Bucktail mines, where it has been locally known as the "Kane's Gas Vein."

The bed varies from 2′ 8″ to 2′ 10″ although occasionally it contains but 1′ 4″ of good coal, where squeezed.* The best coal is in the center, about 10″ thick, an equal amount of top being quite sulphurous and hard to mine, while the lower portion of the bed, averaging 1′ 3″ thick, also contains more or less sulphur.

The general conclusions arrived at during the survey

* It is believed that elsewhere in this vicinity this coal bed swells to 4′ in thickness and during the survey of the county many claimed an average thickness of 3′ 6″ for it.



crop and 3′ thick 125′ inside the mine. The coal mined resembled that taken from the Bucktail mines, with apparently less sulphur. The same bed has been opened towards Montmorency, back of the Schultz barn, where it shows only 2′ 6″ thick. The Clarion coal rarely averages over 2′ and has been sparingly opened.

Montmorency marks the center of the *Johnson Run basin* in Ridgway twp; and a section of the measures north of this point is given in plate 438, the *Middle Kittanning bed* again capping the series with the *Lower Kittanning* and *Clarion beds* represented by seams 3′ and 2′ thick respectively.

In Spring Creek twp. very little coal is contained in the Johnson Run basin as the surface has been eroded very much lower than that of northern Ridgway and Jones twp., where the axis of the basin also sinks deeper. The strata capping the highest summits are, with but one or two exceptions, those immediately overlying the Clarion coal bed; and though the geological map of the county outlines two areas underlaid by the Ferriferous limestone, this bed was nowhere actually found in place. The most important developments of the coal beds have been made around Irwin Mills and along Spring creek. At the former place the *Lower Productive Measures* are only represented by 75′ of rock. The condition of the Clarion coal is unknown, for though the hills are high enough topographically to contain it, the bed was nowhere opened.

Very little search for coal has been made south of the Clarion river in the southern end of township; but the topographical conditions existing there would intimate the presence of a considerable area of the Alton coal beds, with possibly a limited amount of the Clarion bed.

The *Coal Measures of Forest Co.*, although differing in many of their minute characteristics from those found in adjoining counties, bear in a general way, a close resemblence to those in Elk and McKean Cos.*

*Numerous openings have been made in the coal beds in different parts of this area, especially in Jenks twp., in the vicinity of Marienville; but at

*No. XIII in Jefferson County.**

The two most conspicuous features of the geological map presented with this report are *1st*: The presence of the *Barren Measures* largely in the south and south-east portions of the county and their replacement by the ***Mauch Chunk*** (No. XI) and *Pocono Sandstone* (No. X) ***measures*** along the Clarion river and the Red Bank on the Armstrong-Clarion line, a direct result of the general ***north-east rise*** of all the measures and the gradual shoaling of all the basins from south-west to north-east, and *2nd:* The wide out-spread of the *Ferriferous Limestone* west of the Perrysville anticlinal, forming a valuable "key rock" to the geology of three-fourths of the county and a sure indication of the commercial coal areas.

Six fairly well defined anticlinals have been located and they sufficiently suggest the stratigraphy of the district. These arches are low and the adjoining synclinal basins shallow, so that the whole thickness of strata outcropping at any one point in the county does not exceed 500′. One of the most marked features is the rapid deepening of the *Reynoldsville-Lisbon basin* north of Rockdale, owing to the north-east expiration of the Perrysville axis, permitting a

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the time of the survey of this county in 1885 no effort had been made to mine coal, either for general local consumption or for shipment to near or distant markets. The abundance of wood has always furnished ample fuel

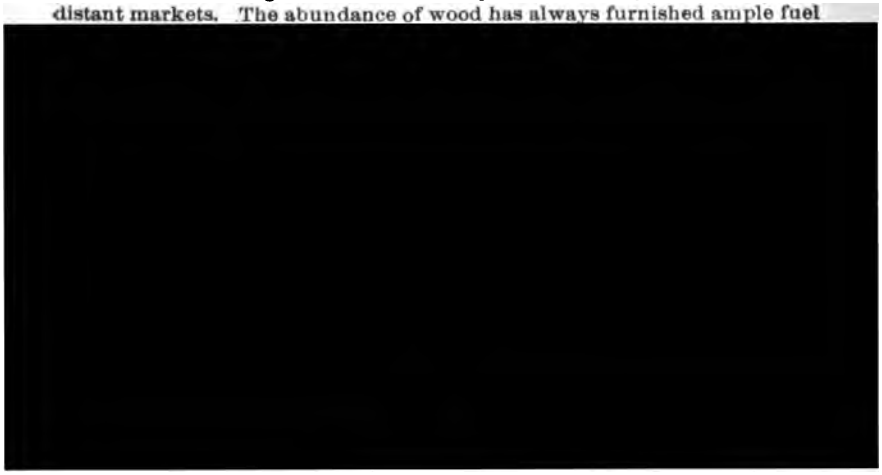


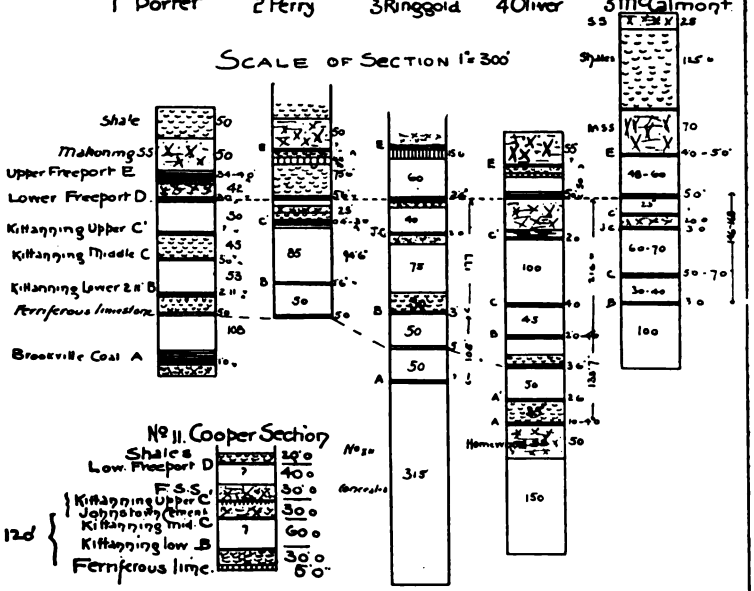
PLATE 439.

No XIII Allegheny Coal Series in Jefferson Co Pa

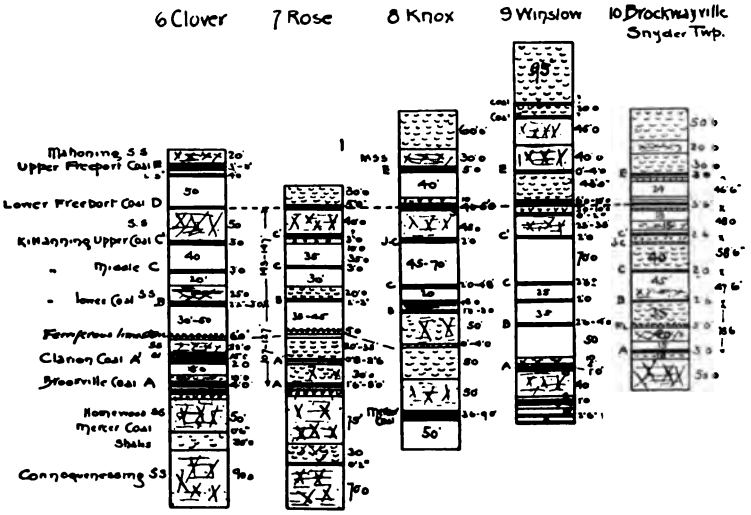
Vertical Sections exposed in different townships Rep H⁶

1 Porter 2 Perry 3 Ringgold 4 Oliver 5 McCalmont

SCALE OF SECTION 1" = 300'



6 Clover 7 Rose 8 Knox 9 Winslow 10 Brockwayville Snyder Twp.



EVD1



northern extension of the Barren Measures (and of course the whole of the underlying Lower Productive group) far beyond its natural limits.

Plate 439 shows 11 vertical sections of the *Lower Productive Measures* in various parts of the county, which sufficiently illustrate the stratigraphy of the district and the varying intervals between coal beds. Other plates (440–41–42 and 43) show the individual characteristics of the several coal beds of the series in the *Smicksburg, Leechburg-Apollo, Reynoldsville-Punxsuatawney, Brockwayville, Centerville* and *Fairmount coal basins*, while plate 440 is entirely devoted to illustrating the variations of the *Freeport lower coal D* in the Punxsuatawney-Reynoldsville district the principal mining area of the county.

The aggregate thickness of the *Lower Productive* (*Allegheny River*) *Series No. XIII* is about 300′, and the measures are exceedingly uniform throughout the county.

The *Freeport upper coal E*, though nearly always present wherever the land is high enough, is not a reliable mining seam in Jefferson Co. and possesses no value whatever throughout the Perrysville region and along Little Sandy. Along the eastern side of the county it is often sufficiently thick, but then slaty and pyritous. At Reynoldsville 4′ thick in places, but hardly good enough for shipment. At Brockwayville it is better, but thinner.

The *Freeport upper limestone* attains its best development along a narrow belt between Perrysville and Worthville, thinning and fading away east and west, but reappearing around Brockwayville and at Clayville on Mahoning creek.

The *Freeport lower coal D* not only gives distinctive value to the whole Reynoldsville-DuBois-Punxsuatawney basin (where however it is subject to many rolls and rock-faults) but it is the principal seam of Jefferson Co., wherever the hills are high enough to include it. It is however thickest and best in the Reynoldsville-Punxsuatawney basin; but it is not equally good everywhere, nor as uniform in thickness.

The *Freeport sandstone* is seldom prominent; slaty in

the Perrysville region, and also thin bedded and obscure at Punxsuatawney, on the upper waters of the Mahoning and on Little Sandy. It acquires more prominence and massiveness at Reynoldsville, 30′ to 40′ thick.

The *Kittanning coal group* is of small importance at all points. The *Kittanning upper coal C'* nowhere exceeds 3′ and seldom half that thickness. The *Johnstown cement* is always present as a small layer of impure fossiliferous limestone, characterized by minute univalve fossil impressions. The *Kittanning middle coal C* is thick but impure in Knox and McCalmont twps., and shows at its best in Union, where it furnishes most of the local supply. The *Kittanning lower coal B* is usually regular and persistent, but mainly small and of poor quality, being largely called upon to furnish fuel for calcining the Ferriferous limestone.

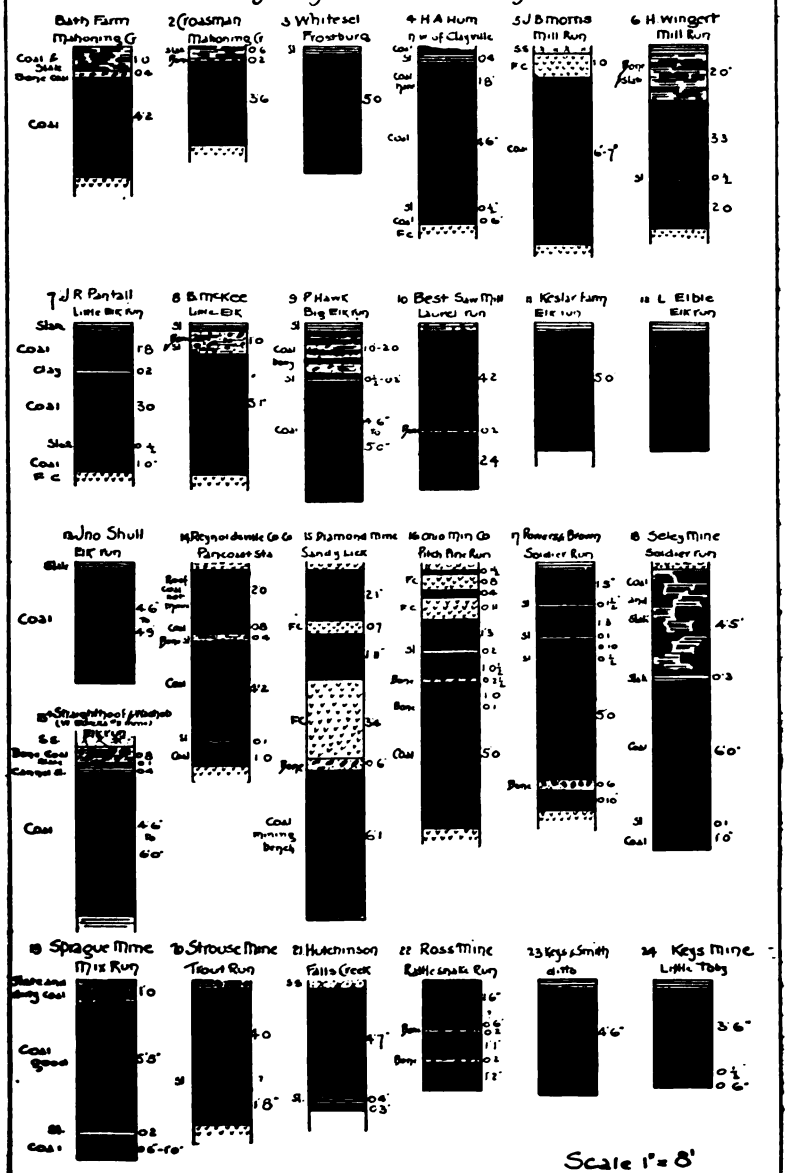
The *Buhrstone iron ore* has its vanishing limit in Jefferson Co. and is frequently obscure. Along Red Bank it crops nearly to Brookville, but generally valueless. The *Ferriferous limestone** also loses some of its prominence as displayed in Clarion, Butler and Armstrong Cos. It can be traced with difficulty a little north from Brookville, changing first into a cherty limestone and then into a sandstone through all northern Jefferson Co. In the northeast corner it re-appears at Shaffner's Corners, and again at Brockwayville, but no further east; but it can be traced south to Rockdale where it is again lost approaching Sandy Lick valley.



PLATE 440.

No XIII Allegheny Series in Jefferson County Pa Rep H6

Sections of the Lower Freeport Coal Bed D in the Punxsutawney - Reynoldsville - Brockwayville Districts





land farms, in two detached knobs, where the Upper Freeport limestone shows 6′ thick. In southern Porter township this bed is mined in the ravine of Big Hamilton run, from 3′ 6″ to 4′ 0″ thick. On the James Stockhill farm northward it carries a rider 3′ thick separated from the lower bench, 4′ 0″ thick, by a foot of slate; total bed section 8′ 0″. The rider is local, thinning in all directions. It crops around headwaters of Dean's run and the county line at D. McGregor's. It has been exposed to the middle branch of Pine run northwest of Mr. Adams' house, 3′ thick, with frequent binders and knife edges of slate, but without persistent partings; in some places it reaches 4′ in thickness.

In Perry township partial sections of the Freeport group are frequent; but bed E is generally thin, whilst its underlying limestone is of commanding importance. The latter bed is finely exposed on Foundry run, 10′ thick, divided into three layers by partings of slate. The top is an impure cement; the middle an excellent limestone, and the bottom also a good limestone. South of Whitesville it is quarried on L. Bath's farm; but it is apparently absent around Frostburg, as is also bed E. Close to Perry church the most extensive developments on the limestone occur, about 6′ thick, and all excellent stone. It is present in the northwest corner of the township, where bed E shows only a faint outcrop of coal.

In Ringgold township, in a small ravine west of Caylor's run, the coal is probably contained in highland on the H. Freas property, 3′ thick. On the west branch of Eagle run it was opened on P. Snyder's land, subject to many horsebacks, at best 3′ 5″; top bench, hard and slaty, 1′ 2″; middle bench, good, 1′ 8″; bottom bench, hard and slaty, 0′ 7″. In the Mt. Tabor road it is 3′ 8″ thick and the same on the Booser property, south of Mt. Tabor, in the valley of Big run; at Smathers, only 2′ thick. In Oliver twp. it seems to be generally wanting, as at Frostburg in Perry and in the Punxsuatawney district; but the hills are rarely high enough to contain it.

In Beaver township its horizon is reached at only one place, in the heart of the Leechburg basin, about one mile north of Worthville; but though unopened, it is presumably small and unimportant.

In Knox township, west of Knoxville, in the ridge between Indian Camp and Lick runs, its outcrop is scarcely detected, thus agreeing in obscurity with its condition in the southern tier of townships; but one mile north, at J. Mathew's, this coal attains a thickness of 5′, which is also its reported thickness on the Rhoads property in Sandy Lick valley.*

In Young twp. bed E is not less than 50′ beneath water level at Punxsuatawney in the *Fillmore* (Lisbon) *synclinal*. It varies from 40′ to 60′ above the great Freeport lower coal D of this district. Bed E, though a seam of considerable thickness, yields inferior fuel to bed D, and it is furthermore ruined by being roofed directly by the Mahoning sandstone. It is not opened on Mill run; nor in the small ravine to the west; nor on Washington creek to the south. In the ravine of Little Elk run it is exposed by J. Conrad, Weaver and William Smith, varying greatly within short distances, both in thickness and composition. Much of it is slaty. On the

* Throughout northern and northwestern Jefferson county none of the territory is sufficiently high to contain this coal, north of the Allegheny Valley R. R., except to a limited extent and without commercial value, in Washington and Snyder twps.

E. Weaver farm it shows 5′ 3″ thick, out of which there are 1′ 3″ of poor top coal, reducing mining section to 4′. It carries a waving sandstone roof and therefore the bed varies greatly. William Smith's mine is on the opposite side of ravine and one-half mile west, showing about 4′ of slaty and indifferent coal. In the main valley of Elk run its outcrop shows on the Hawk farm 50′ above bed D; but the bed is much more widely and favorably known in McCalmont twp. Its limestone, so prevalent in Perry, shows here at Clayville on Mahoning creek.

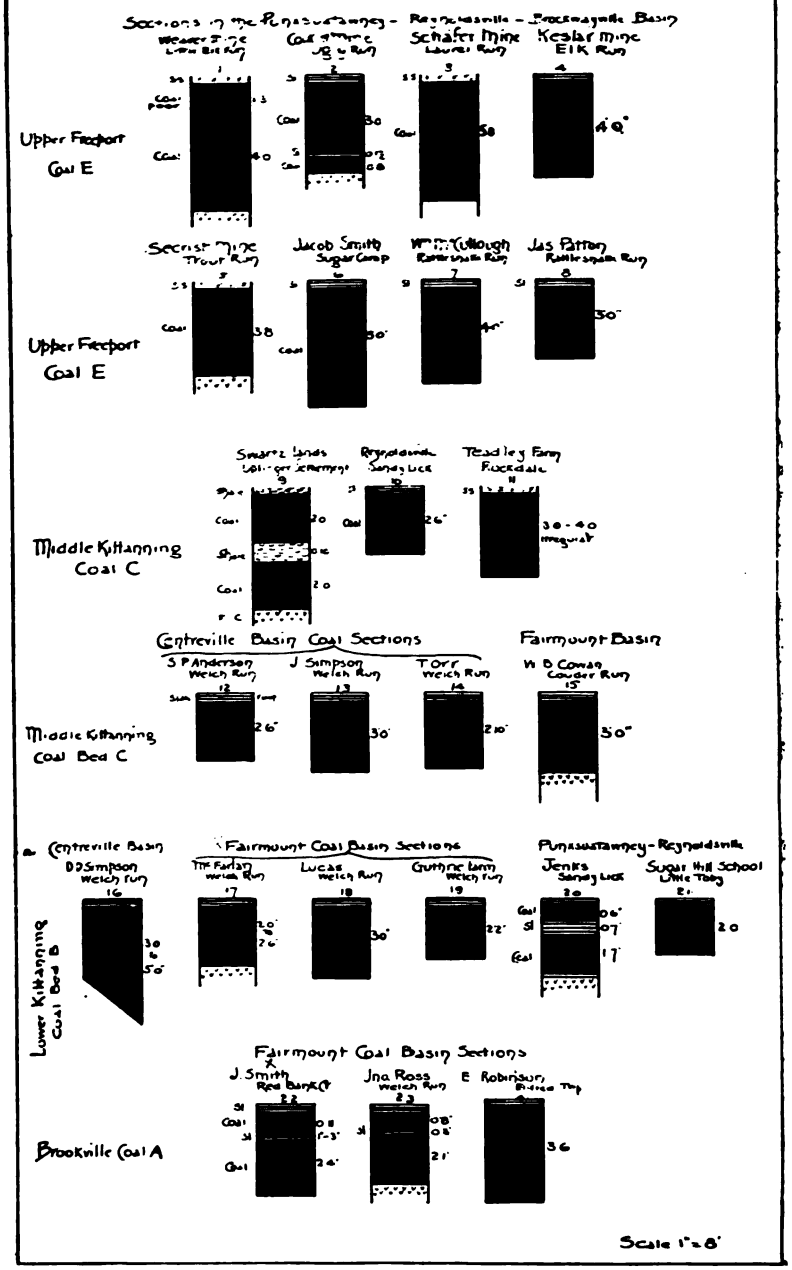
In Bell twp. this coal is only exposed in the valleys of Ugly run and Canoe creeks, its horizon touching water level one mile below Finley's saw mill; but though not there exposed, it is opened further up Canoe creek at McQuown's mills, about 4′ thick. In Gaskill twp. the bed has been proven to have workable thickness; but the developments are too few to say much about it in detail. On J. H. Colquitt farm, close to the Indiana Co. line, 1 mile east of Ugly run, it has been largely mined for local use, though its outcrop is extremely limited by the Chestnut Ridge axis. It is 3′ 9½″ thick in two benches; upper 3′ 0″; slate 1½″ and lower 0′ 8″. The *Freeport upper limestone* in this part of the field underlies its coal by 25′ to 30′, as in the Blairsville basin of Indiana Co. On Bowers hill the coal shows the same as at Colquitt's, 3′ 6″ to 4′ 0″, which is about its section in the Clover Run valley.

In McCalmont twp. the coal outcrops along the Perrysville axis and is also exposed above water level by the Falls creek axis along Laurel, Big and Turnip runs east of Shamoka to Henderson twp. On J. Bert's farm, north-east of the mill at the mouth of Laurel, the bed is somewhat crushed by the Mahoning sandstone, showing 3′ thick; on Schafer's farm adjoining, north of the tannery, it is 4′ 7″ to 5′ 0″ thick. It is however both slaty and pyritous and does not compare with bed D in value. At Keslar's on Elk run it is 4′ thick, 50′ above bed D. Northward its exposures are few and the bed becomes irregular.

In Winslow twp. this bed is a very uncertain factor of the section. Around Reynoldsville it is wholly absent, as well as under the plateau of Trout and Mix runs. In Soldier run ravine it has shown 4′ thick; but it is doubtful if it maintains such thickness. Indeed economically considered throughout the Reynoldsville-Punxsuatawney field it is universally bad, much disturbed by a massive (Mahoning) sandstone roof, and can be left out of consideration in estimating the commercial coal tonnage of this district. It



No XIII Allegheny Series in Jefferson County Pa





*The Freeport lower coal D.** Commercially considered, this is by far the most important seam in Jefferson Co., as but little coal from other beds finds its way to market. This bed is perhaps thickest around Horatio and Punxsuatawney; but it is subjected to greater variability, its section running from 3′ 8″ to 9′ 0″, usually without parting. In many places it is thinner and even cut out entirely by sand lagoons; but in such instances no attempt has been made to work it. Bony matter often occurs at roof and floor, running up to 6″ and 4″ respectively; but rarely if ever in the body of the seam itself. The mines in this district are chiefly those of the *Berwind-White Coal Mining Co.*, West Eureka Collieries Nos. 1, 2, 4, 5, 6 and 10, 11, 12, the three latter at Anita, in all of which the average yield of coal will be about 5′. Further north are the *Rochester & Pittsburgh mines* at Walston Nos. 1, 2 and 3 on Saw Mill run; *Adrian mines* Nos. 1, 2 and 3 on the next run north, connected underground with the *Eleanora mines* of the same company on Big Run waters, Nos. 1 and 2, in all of which the coal, where not cut out by rock faults, is less variable than around Horatio, yielding more regularly about a 5′ seam.

In the *Reynoldsville district*, where are located the principal mines of Messrs. Bell, Lewis and Yates,—the *Rochester*, *Big Soldier*, *Sprague* and *Hamilton*,—the mining portion of the bed is not quite so thick, though the roof members of coal and slate often bring the total section up to 10′; but the bed still yields an exceedingly choice coal, both for steam and domestic purposes, and unlike the same seam in the *Horatio-Punxsuatawney field*, it is not used for coking purposes here.

As far south as Punxsuatawney and north to Sandy Lick, even the most prolific and regular mines have developed areas of entirely barren territory where the coal bed has been wholly replaced by sandstone and silt, without actual displacement of the seam. What was mere surmise a few years ago, prior to the extensive development of this

*Plate 440 gives a series of sections of this important bed in Jefferson Co.

field which succeeded the construction of the Buffalo, Rochester and Pittsburgh R. R., has given way to certainty now, viz:—that extensive erosion of this coal bed took place, either during its deposition or immediately afterwards, prior to the formation of the great Mahoning sandstone cap. This erosion is in the nature of lagoon*, marking ancient water courses, whose channels were quite as irregular in extent and direction as any existing surface stream at the present day. That they were usually shallow is evidenced by the fact that rarely is the limestone underlying the coal cut out or even disturbed, and actual developments have demonstrated these washouts to be of immense extent in places. In some of the mines at Punxsuatawney the erosion partakes of the character of a large number of small spots, like sand islands in the great coal swamp, in and around which excellent coal has been mined, showing no evidence of distortion, squeezing o faulting.

North of Sandy Lick in the *Brockwayville district* are the *Beech Tree mines* Nos. 1 and 2 of the R. & P. C. & I. Co. where the bed is thinner; and in the Blairsville—DuBois basin of Clearfield Co., the new *Berwind Shaft colliery* near DuBois where the coal is mined 265′ beneath surface, showing a top 1′ bench not mined; 0′ 2″ bony and main bench 5′ 6″ to 6′ 0″. Also the Helvetia Nos. 1 and 2 mines of Mr. Adrian Iselin near Stanley. Other commercial mines are the *Standard*, *Coal Glen* and *Clarion Nos. 1*

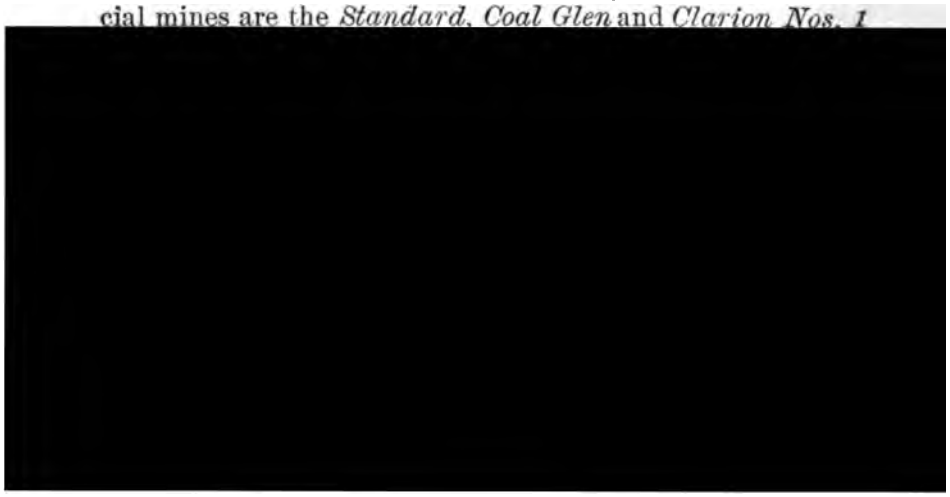
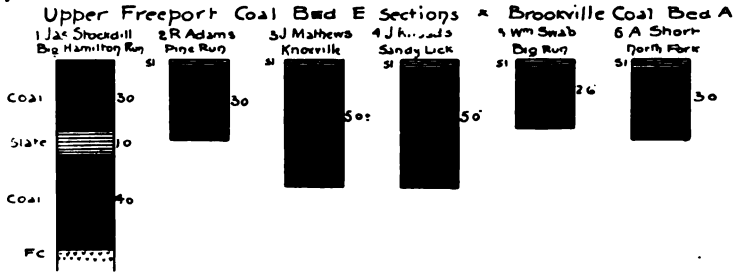


PLATE 442

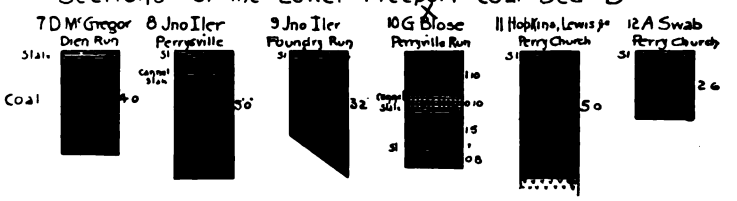
N°XIII Allegheny Coal Series in Jefferson Co Pa

Coal-bed Sections in the Smicksburg Basin Rep. H⁶

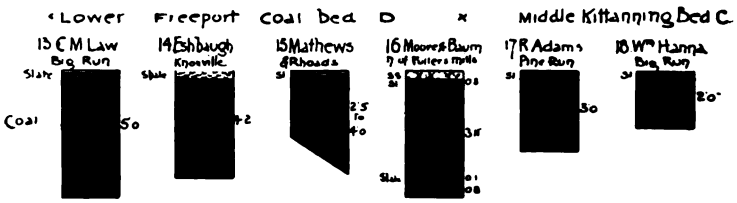
Upper Freeport Coal Bed E Sections × Brookville Coal Bed A



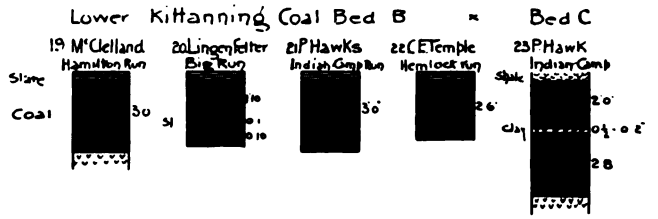
Sections of the Lower Freeport Coal Bed D



Lower Freeport coal bed D × Middle Kittanning Bed C



Lower Kittanning Coal Bed B × Bed C



Scale 1"=8'



Apollo synclinals, in Ringgold, Porter and Perry twps. there are additional areas of this *Lower Freeport coal* where the bed is thinner but in good condition, as the mine descriptions to immediately follow will show; but as yet this area is without railroad connection and too the Lower Freeport coal bed D does not here show that predominating character of a thick and good coal seam that it does so generally to the east of the Perrysville arch.

Along the Sandy Lick valley between Reynoldsville and Pancoast this bed is strangely wanting, all attempts to locate commercial areas of good coal there having so far proved failures; and while the bed maintains its integrity through the Brockwayville-Rattlesnake run district and even across the Little Toby into Elk Co., it becomes gradually thinner and wholly wanting along the Philadelphia & Erie R. R.

Township Notes.

In Porter twp., the Freeport lower coal D occupies a considerable area, but it is rarely over 3' thick and seldom opened. In Perry twp. adjoining, all through the Smicksburg basin, it shows a thickness superior to any other coal seam of the Lower Productive coal group, varying from 3' 2" to 5' 6" in thickness. It has been quite extensively developed around Perrysville for a local supply of coal, showing on the John Ihler farm, about 5' thick, parted near the top by a layer of impure cannel slate. But across the hill on Foundry run the same coal is only 3' 2" thick.

On the George Blose farm in the valley of Perrysville run the coal shows the following typical section: Top coal 1' 10"; cannel slate 0' 10"; coal 1' 5"; slate thin; bottom coal 0' 8". Total 4' 9". Westward and northward from Perrysville its mining and chemical condition materially improve; at Blose's its analysis shows F. C. 53.496%; V. M. 32.173%; sulphur 3.361% and ash 10.090%, so that it is a worthless coal, except for local farm use. Even in this part of the field the bed is somewhat affected by sand intrusions, one of the entries of the Blose mine showing a wedge-shaped mass of sandstone coming into the seam below the cannel slate, dividing the bed into two parts, though confined to a narrow area, 100' long and 50' wide, starting as a knife-edge and gradually increasing to 18". Horses of clay also considerably disturb the coal here.

On the T. Ball farm, north of Whitesville, on the east side of the Perrysville axis, bed D has been opened and is now extensively mined at West Eureka No. 4 colliery of the B.-W. C. M. Co. where the whole section shows 5' 6", the main mining bench being 4' 2" thick, above which comes 0' 4" bony coal and 1 0" of top coal, not mined. On the Croasman and Postlethwaite farms near Whitesville, a more typical section shows, with top coal and slate 0' 6": bony coal 0' 2" and coal 3' 6", a total of 4' 2". The coal is of good quality at

both places. As a direct effect of the axis, the outcrop of this coal extends far up all the branches of Mahoning creek on the north side, between Whitesville and Clayville, taking cover on the main creek twice in the big bend east of Whitesville at the West Eureka colliery No. 4; cut out again at the next bend north to run far up Ross run, but again passing beneath the main Mahoning near the Perry-Young township line before reaching Horatio. In the elevated country around Frostburg, over the arch of the Perryville axis, the *Freeport group* occupies the hill-tops; but only to descend on the east side to creek level at Horatio and Clayville, at West Eureka mines Nos. 1, 2, 5 and 6, where it is extensively mined, and yields a good clean coal averaging 5′ thick and varying from 3′ 6″ to 9′ 0″. All around Frostburg this coal shows good mining thickness, 4′ 6″ to 5′ 0″ thick, occasionally somewhat slaty and bony but generally good; through the P. & R. Whitesel farms 5′ 0″; H. Depp's 4′ 6″, somewhat irregular and disturbed by clay veins; at R. Anthony's 5′ thick, without partings. Again on the old Bell, Martin and McGee farms, southwest of Frostburg, where the seam is still 5′ thick, but somewhat slaty and impure. A large proportion of this area, extending north to Olivesburg, but mainly in Young township, is now owned by the Rochester and Pittsburg C. & I. Co., whose mines at Walston on Saw Mill run and at Adrian on Elk run, are now extracting an enormous tonnage of excellent coal annually from this seam along the western flank of the Lisbon basin, the coal averaging about 5′ thick, with great regularity of section but frequently cut out suddenly by sand lagoons as already mentioned. Being continuous across the axis, considerable areas await development along the Oliver township line, though very little of it extends northward into the Big Run valley. To the west and south in Perry a large local household supply is obtained from banks on the Hopkins, Neel, Lewis, McCracken and Courley farms, where the coal is 6′ thick, but with little slate, showing an excellent firm and hard seam, only spoiled by a rather large percentage of sulphur (2½%).

In Oliver township very nearly all of this coal is contained within the Lisbon basin, though its horizon is reached in detached knobs north of Little Sandy creek in the *Leechburg-Apollo synclinal*. The best exposure of the coal in the Big Run valley, along the south side of the township, is on property of C. M. Law, two miles west-southwest of Olivesburg, where it is

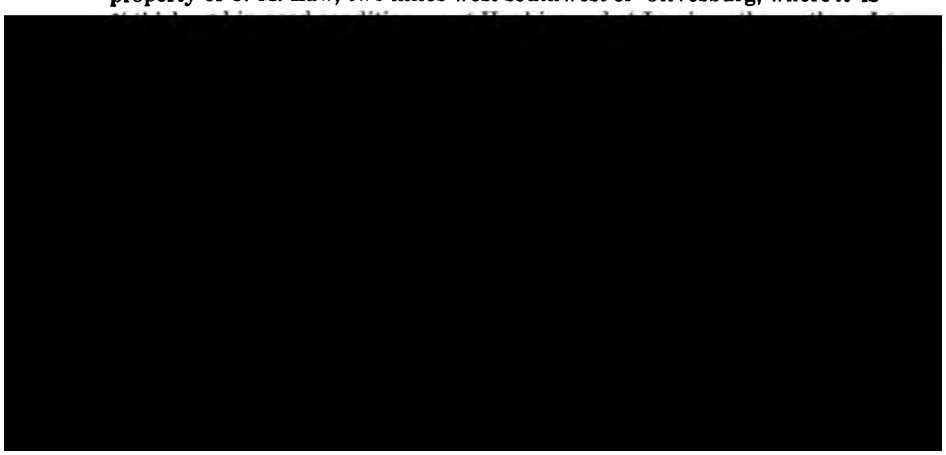
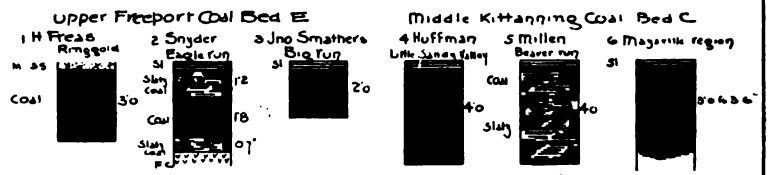


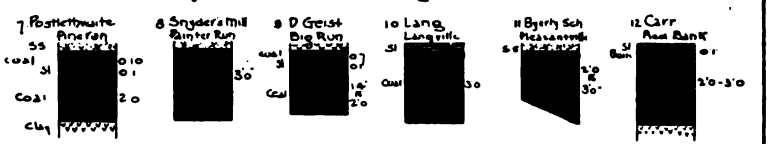
PLATE 443

No XIII Allegheny Coal Series in Jefferson Co Pa

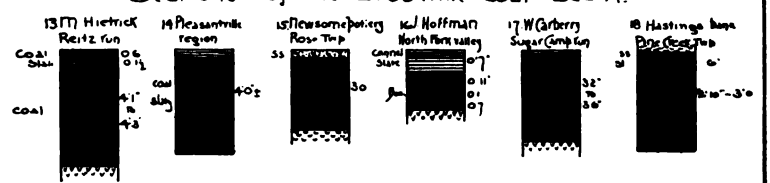
Coal-bed Sections in the Leechburg-Apollo Basin Rep H⁶



Sections of the Lower Kittanning Coal Bed B

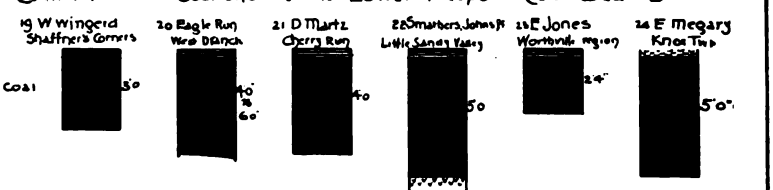


Sections of the Brookville Coal Bed A.



Coal A

Sections of the Lower Freeport Coal Bed D



Scale 1" = 8'



height the coal shows one solid bench 4′ thick, without partings and of good quality. In the valley of Eagle run, on the west side of the Leechburg basin, it has been reported 6′ thick, of which 4′ can be seen at an old pit. In the valley of Painter run, close to the Armstrong line, its outcrop shows; but very little is known of the character of the coal. In the valley of Cherry run, on the north side of the hill in the *Leechburg-Worthville basin*, this coal is thought to be opened on the D. Martz farm, near Milliron's grist mill, 4′ thick; but its outcrop is sparingly explored all along the south side of Little Sandy Creek valley.

In Rose twp. a limited area of bed D is found in the *Worthville-Leechburg basin* in the south-east corner only a few acres in extent. On the E. McGary farm at the Knox twp. line, the coal is reported opened close to the hill top 5 thick, without partings and free from pyrites. In Knox twp., straddling the Waynesburg axis south-west of Knoxville, there is a considerable area of the Freeport lower coal, which also crops in isolated patches northward and in one hill east of Knoxville. The bed however is only valuble here for a local supply of coal, owing to its geological and geographical position. On the W. Borland farm, on Lick run, the coal avereges 4′ 6″ to 5′ 0″ thick and mines out easily; but its clay shale roof admits water freely and somewhat stains the coal. In this mine a top bench of hard cannel slate first appears as thin projecting finger points, which subsequently unite further in to make a solid top bench 2′ thick. Its outcrop extends around the head of Lick run, past the McGary farm in Rose twp. and thence on to Five Mile run. It is opened on the Shafer, Cummings, Eshbaugh and Stewart farms, showing much the same condition as at Borlands. The bed is uniform and regular and about 4′ 2″ thick, and though somewhat pyritous (1½%) it shows less than 5% of ash and yields a good coal with over 38% volatile matter. At Mathew's farm north of the Brookville road it shows 4′ thick; but at Rhodes near by the same bed is only 2′ 5″.

Young twp. is now a highly developed section of the *Lower Freeport coal D* through the operations of the Berwind-White Coal Mining Co. and the Rochester and Pittsburgh C. & I. Co., established since the extension of the Buffalo, Rochester & Pittsburg and Pennsylvania R. R. systems into this region, after the survey of Jefferson Co. was made. Some mention of the mines at Horatio, Walston, Anita and Adrian have already been made, the bed outcroping along Ross, Saw Mill and Elk runs, being generally beneath water level on the Mahoning, the *Lisbon synclinal* passing just east of Horatio and through Punxsuatawney, and the bed being buried in it all through the south-east portion of the township. As in the Perrysville region the interval between the two Freeport coals varies throughout northern Young twp. from 40′ to 60′. Bed D shows a very wide variation in section here as already stated; but as mined commercially it may be said to average about 5′ in thickness or 7,000 tons per acre. At the Carmalt farm north-west of Clayville it shows imperfectly 4′ 6″ thick; but on the Hum farm, higher up the ravine, it is said to carry a roof member 3′ thick over a 4″ slate. The lower part of the bed near the crop was 6′ 8½″ thick, with a small 0½″ slate parting 0′ 6′ above floor. The coal is good and clean and mines easily, yielding about 35% of volatile matter and less than 1% of sulphur and low ash. At the Morris pit to the north its main bench is from 6′ to 7′ thick. This area is now embraced within the West Eureka Nos. 1 and 5 mines.

On Saw Mill run to the north, around the Walston mines of the R. & P.

C. & I. Co., on the Jones, Morris and Kurtz farms it shows from 5′ to 6′ of excellent coal. Occasionally small knife edges of slate appear and also wedges and seams of iron pyrites, but in no case of sufficient thickness or frequency to damage the bed. The coal is rather more tender and friable than usual in this basin and hence its product is quite largely coked.

The Wingert mine, well up a narrow branch ravine of the run, shows the section to contain 2′ 0″ of top bony coal and slate, the mining section being 5′ 3½″ thick, with the 0½″ slate about 2′ 0″ above the floor. The upper bench is hard and mines out in large lumps; the lower bench shows a columnar structure and much more friable, the whole yielding 1½% of sulphur and 4½% of ash. In the ravines of Elk and Little Elk runs are situated the Adrian mines Nos. 1, 2 and 3 and the Anita (West Eureka) mines Nos. 10, 11 and 12, opening up immense areas of this coal bed, which rises northwest regularly and more rapidly to the Perrysville axis and north-east less rapidly towards Reynoldsville in the same basin. The Adrian mine tunnel is connected underground with the Eleanora operation on Big run, and presents a striking example of uniformity and regularity in this coal seam here besides serving to drain south-westward enormous areas. Ascending from Punxsuatawney the coal first appears above water level beyond the forks at the Adrian mines. On Little Elk it was opened on the J. S. Kennedy farm 6′ thick and further up on the McKee and Pantall farms, where it showed 5′ 10½″ thick, with a thin 0½″ parting 1′ 0′ above the floor, and occasionally a clay parting of 2″ at about 1′ 8″ from the top, not persistent however. At the McKee mine the section recorded by Mr. Platt gives 6′ 1″; but the top 1′ 0″ is bony and slate, bringing the mining bench down to the district average of 5′. At the old P. Hawk mine on the main creek close to the forks (now Adrian mines) the top coal, with some bone and slate, varies from 1′ 0″ to 2′ 0′ beneath which comes a persistent slate from 0½″ to 2″ and then a clear mining bench 4′ 6″ to 5′ 0″, the latter a good clean, bright and handsome coal.

Bell twp., next east of Young, is almost entirely occupied by the *Barren Measures* so that the *Lower Productive coals* are everywhere beneath water level save along the Indiana Co. line on the south along the valleys of Canoe creek and Ugly run. Owing to the collapse of the Indiana anticlinal to the south, the stratification is nearly horizontal. Of the Barren Measures about 300′ are exposed; of the Lower Productive group 100′



slaty. The Shafer coal is 5′ thick; but the bed carries the usual parting 1½″ thick with only 3″ to 4″ of bottom coal beneath it and a mining section of 4′ 6″ above the latter carrying a hard bony parting about 1′ from the bottom, as at Eleanora.

The Straighthoof bank at the head of Elk Run valley, was reported in H 6 to be on one of the lower Kittanning coals; but recent developments point to its being bed D, with a lower mining bench of 6′, above which comes 4″ of cannel slate, 1″ of slate and on top 8″ of bony coal and slate, in all 7′ 1″. This same seam is opened on the J. Wachob farm, where the coal is equally good, but with the lower bench reduced to 4′ 6″. The Kesler farm, lower down the stream and about ¼ mile northeast of Smith's saw mill has an opening on bed D, showing a handsome clean bed of coal 5′ thick, with no partings and only a few knife edge binders; a low percentage of sulphur and ash, and well situated for mining. This tract is now worked by the Berwind-White C. M. Co. at their West Eureka No. 10 mine. On the Eible farm 1 mile east it again shows 5′ of coal, yielding the same average quality that this bed shows all through the Elk Run district. John Shull has opened the same bed on the western slope of the hill, near the level of the east branch and 1 mile south of Shamoka Corners, ranging from 4′ 6″ to 4′ 9″, and rather slaty. The Brown mine in the Brown-Uplinger Settlement in the north end of the township, around the head of Little Sandy waters develops a limited area of the Lower Freeport coal, of good quality but limited in extent, 4′ 8″ to 5′ 0″ thick.

Henderson twp. and Gaskill twp. lie along the Clearfield Co. line, the former exhibiting a limited area of the Freeport coals along the east branch of the Mahoning whilst the latter shows an increased area along Clover run and Stony run, extending up the west flank of the Chestnut Ridge axis. Drill holes put down in Henderson in the area between the McCalmont-Bell line and Stump creek do not show the Lower Freeport coal over 3′ and sporadic in occurrence. In the north-east corner of this township at Sykesville on the R. & P. R. R. along Stump creek, the synclinal axis of the DuBois basin is located; and this structural effect has been taken advantage of by Messrs. Bell, Lewis & Yates to locate a shaft* 116′ deep to

* Here one of the boldest and most costly tunnels was driven to connect shaft and mine, 9,100′ long, and taking advantage of the 100′ difference in level between top of shaft and mouth of Big Soldier run mine drift, an enormous area of splendid coal was rendered self-draining, the water backing up for 4500′ in heading from shaft, leaving above this water level 4600′ of heading to the crop, or an area af about 2,500 acres. Until this high area is all mined out no pumping will be required in this mine. In summer of 1892, when the heading had been driven about 2,000′, rising about 2½′ per 100′, the tunnel showed the sporadic occurrence of the coal bed in this region and very plainly the ramifying sand lagoon responsible for its erosion. At foot of shaft 7′ of good coal was developed, as drilling had indicated; but advancing along heading, coal thinned out to nothing in 300′ and was replaced by rock even to the extent of cutting out limestone floor for the next 160′. This barren area was succeeded by a productive zone 200′ wide, but that in turn by 1200′ of rock tunnelling to the then face. As far as could be ascertained at the time, even cross-entries driven out into productive portions from main heading, failed to demonstrate any great

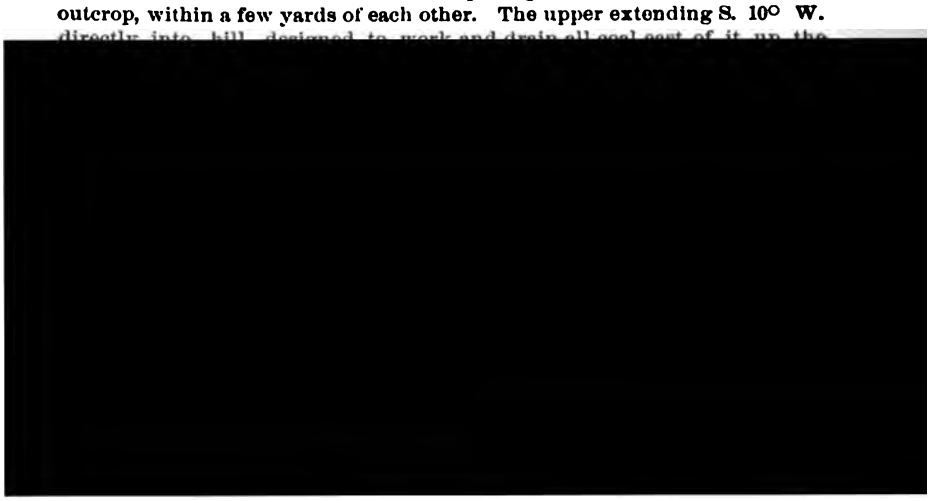
drain their Big Soldier run mine and tributary territory to the north-west in Winslow twp., where the outcrop of this coal is 219′ higher than at the shaft 2 miles distant. In this connection, mention might be properly made of another Clearfield area, but recently opened up by the Berwind shaft colliery to the east of DuBois, where the Lower Freeport coal shows a mining bench 5′ 6″ to 6′ 0″ thick, 0′ 2″ of bony on top, over which comes 1′ of coal not mined; 265′ below surface. By the extensive use of the diamond drill an elliptical shaped area in the trough of the basin (here pitching north-east towards the A. V. R. R.) was defined, within which the coal was found quite regular and persistent, extending south-west from the railroad to West Liberty; outside this circumscribed area the coal was found irregular and uncertain, so that beyond some isolated finger ends, a very large area near by is thought to be commercially barren of good mining coal.

Returning to Gaskill twp., where the prevailing dip is northwest, away from the Chestnut Ridge axis, the *Lower Freeport coal* is totally undeveloped, although its outcrop occurs along the valleys of Clover run and Ugly run. It is claimed to show 4′ thick here, somewhat similar in section to the mines in north-east Indiana along the waters of the Little Mahoning and Cush creeks.

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extent of good coal, although it is believed from drill records, that excellent mining areas exist on either side at no great distance. Certain it is however that a very extensive and ancient estuary was developed here, how extensive future developments alone can tell, and one with many sinuous branches, spoiling the integrity of the mining field. In brief, nothing can be predicated as to how extensive a mine may be in this Jefferson Co. district, or how valuable, until it is actually developed, although no like area of bituminous coal in the state has been drilled to the same extent as this in advance of mining.

The *Helvetia mine* (in Clearfield Co.) on eastern flank of DuBois basin, about 1½ miles from Stanley station on B. R. & P. R. R. developed a similar "fault" in the *Lower Productive coals* only material displacing coal there is much finer and more like silt. Two openings in 1892 had been driven on outcrop, within a few yards of each other. The upper extending S. 10° W. directly into hill, designed to work and drain all coal east of it up the



Winslow twp. has been the seat of a very large development of this coal, where it is locally known as the "*Reynoldsville Gas Coal.*" Both the Perrysville and Falls Creek anticlinals extend through its boundary, but the former is decidedly the more important and stronger, the latter creating only a faint roll, barely sufficient to affect mine drainage. The *Reynoldsville synclinal* passes almost directly under the town and rising rapidly north-eastward it lifts the Freeport coals into the air north-east of Pancoast and accounts for their absence over nearly all eastern Washington. All the coals of the *Lower Productive group* are exposed in this township; but the Lower Freeport bed D is of paramount importance, being prëeminently a fine bed throughout the Reynoldsville region. It is mined largely at *Rochester*, *Big Soldier Run*, *Hamilton* and *Sprague mines* of the Bell, Lewis and Yates Co., along the waters of Sandy Lick.*

The old Pancoast mine of the Reynoldsville Coal Co. is directly at that station 150' above the creek, separated from its 2' limestone bed by 15' of shales. The entire bed is 8' 3" thick and quite regular, showing an upper bench 2' 0" thick, not mined; coal 0' 8", slate and bony coal 0' 4"; coal, main bench 4' 2"; slate 0' 1" and coal 1' 0". The coal is of excellent character, very free from ash and not troubled with pyrites.

The Washington Colliery, 1 mile east, shows the same character and section. At the Diamond mine, 1 mile north of Reynoldsville, developing two small outlying areas, the bed was found to carry a parting of 3' 4" of fireclay near center, Above it there is 4' of coal again parted near middle by 0' 7" of fire clay. Beneath the main parting there is 6" of bony coal and a good bench of coal 6' 1" thick, which is the only merchantable portion of the seam and exists in superb condition here, of which only the lower 5' is taken out in mining—yielding on an average F. C. 60%, V. M. 34%, sulphur 1% to 1.4% and about 4% of ash. The balance of the seam is worthless, yielding anywhere from 2½% to 3½% of sulphur and from 10% to 15% of ash.

The Ohio Mining Co's. colliery, at Reynoldsville, shows the coal with a total section of 10' 9½"; but the upper part of the seam is much parted and broken (see section plate 440) and only the bottom 5'.0" bench is mined. This part of the bed yielded a first class coal, with less than 1% sulphur and slightly more than 3% of ash.

Powers and Brown's mine, on a small branch of Soldier run, ¼ mile south-east of Reynoldsville, was opened in another handsome area of coal, with the bed 10' 1" thick; but again only one main 5' bench can be relied upon for good coal, below which in this mine occurs 6" of bony coal and 10" of coal. A large portion of these two mines are now exhausted, and the developments of these and many other collieries all go to prove that no matter what the total height of seam may be at local points, only the one persistent main bench of 5' can be depended upon for the commercial supply of coal; and the best part of this bench is always the lower part.

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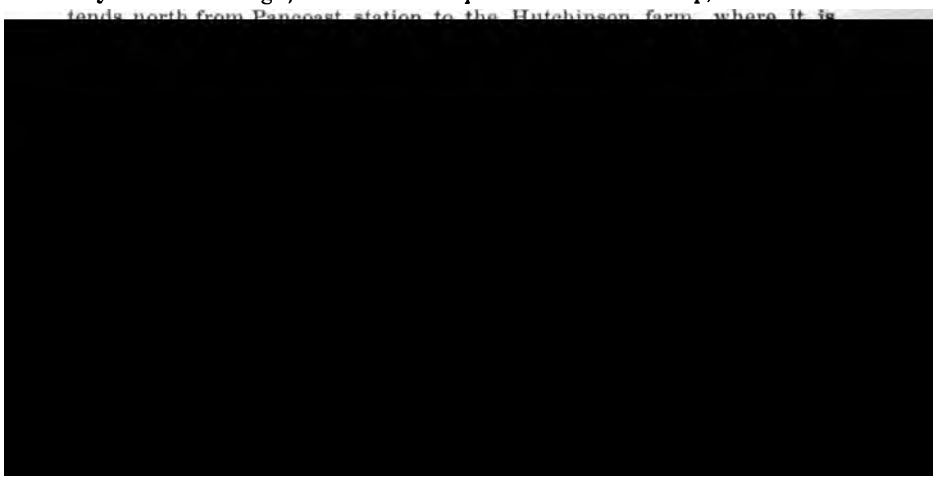
*The right bank of that stream is however destitute of this coal bed between Reynoldsville and Pancoast; so is the left bank opposite Pancoast, though for a very short distance, being present and worked at the old Diamond mine. The absence of coal hereabouts is due to extensive erosion as existing frequently in this district, which fact is extensively discussed in Report H 6 page 130 et. seq.

The Sprague mine on Mix run, shows the entire bed to be still over 10′ thick; but only the bottom part, 5′ to 7′ thick, is sufficiently pure to mine, averaging 6′, with a 1″ to 1½″ band of bony coal and slate 8″ to 10″ from the bottom. The coal is bright and clean and when actively worked, the mine yields about 900 tons a day, half lump over a 1¼″ screen. The coal dips into the DuBois basin, the Falls Creek axis to the west crossing Mix run west of the Big Soldier mine, already referred to, now one of the largest and best equipped coal mining plants in the State. It is connected underground with the Sprague workings and is drained at the shaft on Stump creek, as described. The average yield of coal is between 5′ and 5′ 6″; but the main bench often reaches 6′. Above this bench is 3″ black slate and 4′ 5″ of worthless coal and slate; below it is 1″ slate and 1′ 0″ of impure coal.

The Strouse mine is situated at the head of a small branch of Trout run, nearly due south of Reynoldsville. Here the bed is somewhat irregular and troubled with "horse backs," at its best showing a good 5′ 8″ bench with a small parting beneath upper 4′. The coal yields less than 1% sulphur and under 5% of ash. A number of bore holes have been put down along a tributary of Stump creek between the Falls Creek axis, and the shaft at Sykesville, which shows the coal to lie from 100′ to 150′ beneath the surface and to maintain its thickness of from 5′ to 6′, though in places cut out by rock squeezes. In general it may be said that the Lower Freeport coal yields about the same average thickness in both the Reynoldsville and Punxsuatawney basins viz; 5′ of merchantable coal. In the former district however the coal is generally harder, slightly higher in volatile matter and carries less sulphur and a generally lower ash and bony coal than at Punxsuatawney.

In Pine Creek twp. a couple of patches of bed D are preserved in the center of the *Lisbon basin* along the Reynoldsville pike in the vicinity of Baum's hotel; it is opened on the Baum and Moore properties, and shows a top bench 3′ 11″ thick and a bottom coal 0′ 8″ thick, separated by 1″ of slate, in all 4′ 11″.

In Washington twp. and the Brockwayville district, the principal mines are the Coal Glen colliery of the Jefferson Coal Co. and the Beech Tree mines of the R. & P. C. & I. Co., and the Clarion Mines Nos. 1 to 7. In the Reynoldsville trough, in the southern portion of the township, the coal extends north from Panocast station to the Hutchinson farm, where it is



rise of the basins is now so rapid that the Freeport group is confined to the hills south of the Little Toby. The Freeport lower coal D is the only bed of importance; though not as good around Brockwayville as along Rattlesnake run, it is nevertheless always a good commercial coal. Its section is distinguished by the same features which characterize it in the Rattlesnake valley, namely; a small bench of bony coal and cannel slate at the roof and a small parting black slate a few inches above the floor.

At Lane's (Clark bank) and Cochane's its main bench is about 3′ 6″ thick. Its full character is well shown at Key's mine west of Brockwayville, a cannel slate on top 0′ 6″; coal, main bench 3′ 6″; slate 0′ 0½″ and coal 0′ 6″, the main bench alone being mined.

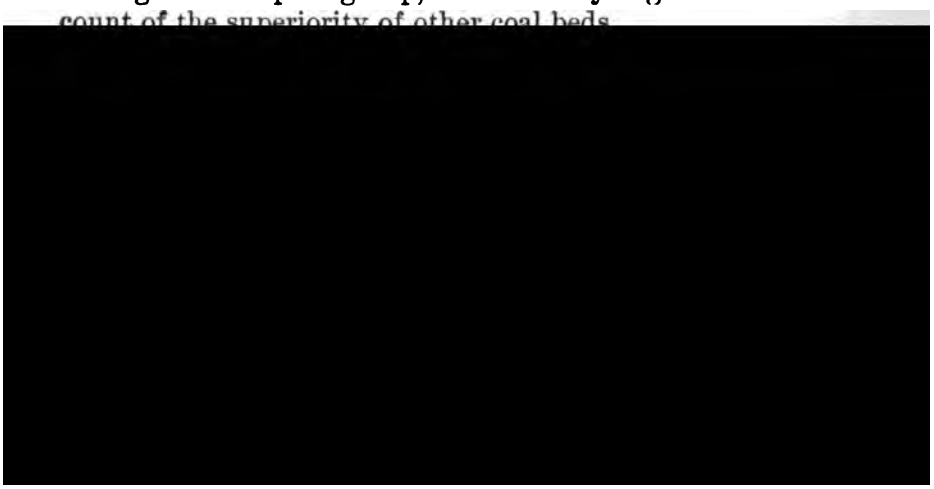
From the foregoing detailed statements of the *Lower Freeport coal D*, it may be inferred that the area of its commercial integrity and value is largely confined to that portion of Jefferson Co. contained within the *Lisbon-Reynoldsville-Dubois basin*, east of the Perrysville anticlinal axis, where it can be counted upon to yield an average of 5′ of clean coal, except in special areas where it has suffered erosion in ancient Palæozoic times.

Certain commercial areas of this bed exist in parts of Porter, Perry and Ringgold twps. but the bed is inferior even at its best, to its condition around Punxsuatawney, Horatio and Reynoldsville—to such an extent as hardly to invite the attention of capital to its development.

Kittanning Upper Coal C′ and Johnstown Cement.

In Perry township this coal is not exposed in the Perrysville district; but the underlying *Johnstown cement bed* shows on the John Iler farm, hard and tough, with irregular fracture; fossiliferous and dark blue-gray. On Foundry run the coal is only 4″ thick at 35′ below bed D; and on the George Blose farm, on Perrysville run, 1′ 6″ thick. Near Whitesville the coal is again wanting; but the cement rock is 3′ thick. In Ringgold the coal is only 2′ 6″ thick in the Pine Run valley, at Stahlman's. In Knox, in the ridge between Indian Camp and Lick runs, the Johnstown cement is noted, 3′ thick, changing to a lean iron ore on M. E. Steiner's property, near Stewart's saw mill; but the Upper Kittanning coal C′ is merely a thin streak here. In Winslow, the coal is regular and persistent at a distance

varying from 30′ to 40′ below the vastly superior bed D. In the Reynoldsville district it shows at Powers and Brown's mine and at Pancoast 2′ thick. In Union it is opened on the L. Daly farm, about one mile south of Corsica, and also on the J. Williams farm. The coal is fairly good and ranges from 2½′ to 3′ thick. It shows the same thickness going southward to Simpson's. North of Corsica, at Hindman's, it shows 2′ 10″ thick. In Washington the hills directly north of Rockdale and east of it contain this coal and the Johnstown cement; but the bed is of no importance throughout central and northern Jefferson county. On the Cooper farm one mile west of Rockdale on the main branch of Falls creek an important section* of the coal measures was obtained, showing the *Johnstown cement* and the *Ferriferous limestone* only 120′ feet apart; and as this Cooper quarry is the only exposure of the Ferriferous limestone in Washington township, the locality is important as serving to remove all uncertainty which formerly existed regarding the identity of these two limestone beds. In Warsaw the ravine of Hemlock run, east of Petersburg, shows the Kittanning upper coal on the John Shadle farm, 2′ 0″ thick and reported underlaid by its bastard limestone. It shows again at the Wilson house, near Maysville. Throughout all the northern townships this coal occurs sparingly, and even where its horizon is reached in the deeper basins containing the Freeport group, it is entirely neglected on account of the superiority of other coal beds.



In Clover the only good exposure is on the S. P. Anderson farm near Troy on Red Bank, 1′ 6″ thick and exactly 50′ above bed B. In Rose at the head of Beaver run, it is opened in Millen's fields, 80′ above the Ferriferous limestone; 4′ thick but worthless by reason of a large amount of slaty coal. At J. Witherow's on the Red Bank divide it is reported 3′ thick. In Knox this coal has been reported east of Knoxville by Mr. Steiner as being 4′ thick, but damaged by a heavy slate parting near the center; and by P. Hawk, 1 mile south of the Windfall lands, where it has been extensively mined. It shows an even and regular bed, but yields a rather indifferent coal, 4′ 10″ thick, upper bench 2′ 0″; slate 0′ 0½″ to 0′2″ and lower bench 2′ 8″. In Winslow, in the Reynoldsville district, several prospect pits show this coal 1′ 5″, 2′ 0″ and 2′ 6″ thick, never mined in the presence of the superior Lower Freeport coal D. In Union south of Corsica, it is 3′ thick on the Simpson farm. North of Corsica, at T. Orr's and Hindman's, it shows 2′ 10″ think. It is clean and good, and with about 3′ average thickness, it yields about the best coal in Union twp. East of Corsica it is 2′ 6″ thick and 65′ below bed C′; somewhat slaty. Around Roseville it shows uniformly 3′ thick, the Cowan mine here being the principal source of supply. The coal is of good character, showing F. C. 54.000%; V. M. 34.440%; sulphur .890% and ash 8.700%. In Washington this coal has been provisionally identified as occurring about 135′ above Falls creek on the Gordon property about 1 mile north of Osborn's mill where it is reported to be 6′ thick, though the measurement requires verification. In the northern part of the township, to the north-west of Rockdale, the same coal is noted on the William Keys farm, 35′ below the Johnstown cement, and also upon Mrs. Teadley's property, still further north-west, where it is roofed by sandstone and has an irregular thickness of from 3′ to 4′. In Warsaw it has only been noted in the vicinity of Maysville, where it has been mined by George Wilson and J. Hick. It has also been developed to the west by W. Frederick and by C. B. Irvin at Maysville. Its thick-

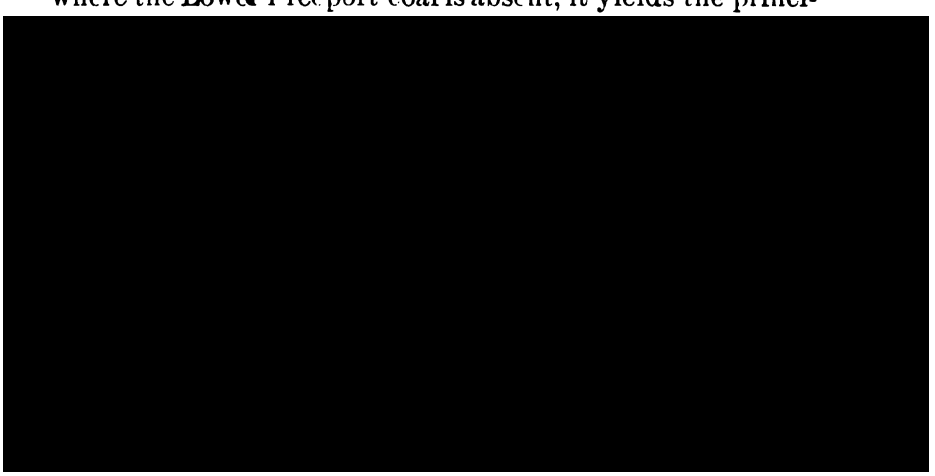
ness ranges from 3′ to 3′ 6″, with slate both in roof and floor. The coal is clean, without partings and is hard and good.*

Kittanning Lower Coal B and Ferriferous Limestone.

In Porter twp. it is probably this coal that is exposed on the McClelland farm, in a small ravine north of his house, where it shows 3′ thick, overlaid by tough slate and thin sandstone. Its outcrop shows along the middle branch of Pine run, 25′ above the Ferriferous limestone, which is here 5′ thick. In Perry near Perrysville, it makes a feeble outcrop along the road north of the village and shows 18″ thick on the Blose farm in Perrysville run.

In Ringgold, the Ferriferous limestone is exposed above water level in the Pine Run valley for nearly 2 miles over the Waynesburg axis. On Caylor run bed B is opened by Mr. Postlethwaite; but here as elsewhere through the Pine Run valley its small thickness precludes it ever becoming a bed of mining importance. On Painter run it is 3′ thick at Snyders's mill and it is also exposed and worked by D. Geist near Worthville, nearly 3′ thick, a typical section showing top coal 0′ 7″; parting slate 0′ 1″, and bottom coal 1′ 4″ to 2′ 0″. The Ferriferous limestone is 4′ thick. The coal is again 3′ thick 1 mile below Worthville.

In Oliver the coal varies from 2½′ to 4′ thick, and in regions where the Lower Freeport coal is absent, it yields the princi-



sils in abundance, and from 5′ to 7′ thick. It carries no iron ore. In the Little Sandy valley Mr. Burkitt claims to have opened bed B 4′ thick and the Ferriferous limestone also 4′ thick, again showing near Geist's saw-mill, with iron ore 7″ thick on top.

In McCalmont, in the Elk run valley, bed B is 2′ 6″ thick at Smithers saw mill. In Beaver the coal is universally a workable seam, but small. It is mined by D. Geist close to the Worthville bridge and J. Wagner. West of Reitz run on the Lang property it is 3′ thick, and 50′ lower down the Ferriferous limestone shows 5′ thick, brownish in color and richly fossiliferous. On the Sowers farm on Tar run the coal is 2′ thick, and on Beaver close to the Rose twp. line, it shows 3′ on the Brocius farm. In Clover it shares with bed A the market for a local coal supply. At Troy on Red Bank it is 50′ above the Ferriferous limestone (4′ thick and quarried by Carrier, McFarlan, Smith and Anderson, with 1′ of Buhrstone ore at latter place) and is mined by Carrier, McFarlan and Anderson, in one bench 2′ 0″ to 2′ 6″ thick. Along a small ravine marking the Clarion Co. line it shows 3′ 0″ thick north of Mr. Lucas' house; on Welch run only 2′ 2″ thick. On Knapp run, joining Red Bank below Dowlingville, it shows in Mr. Kelso's fields, on the S. Shield's farm and on J. Morrison's property, never exceeding 3′, but yielding good coal. The Ferriferous limestone in the same district shows 6′ thick, supporting from 2″ to 4″ of Buhrstone iron ore. On Rattlesnake run, on the Burne property, bed B is 2′ 2″ thick. In Ross, on the Red Bank divide, this coal shows 2′ to 3′ thick on the Carr property, with 1″ additional bony coal on top. West of Brookville, on J. Clement's farm, the coal is 2′ thick. The Ferriferous limestone shows at many places. Below the mouth of Cedar run it is 4½′ thick, with 4″ of iron ore on top, yielding 31.524% iron; 1.376% mang; .028% sulphur and .250% phosphorus. In Knox east of Knoxville, bed B shows 3′ on the Red Bank property and about 30′ below bed C.

In Winslow this coal was exposed by the Central Land and Mining Co. at Reynoldville near creek level, where it proved a worthless seam, 3′ 4″ thick, cut up by slate bands, the coal itself yielding over 3% sulphur and 11½% of ash. In Union this bed has been opened along the Troy road south of Corsica. At Simpson's, near the level of the run, it shows 3′ thick exactly, but increases to 4′ and even 5′ further west in the main Welch Run valley at D. D. Simpson's. Its average in this township will not run over 3′. North of Corsica, at Hindman's, it is reported 4′ thick. All through this township the Ferriferous limestone is everywhere wanting, as it is in Eldred twp. further north. In Pine Creek on the North Fork, the limestone is exposed on the Hoffman farm, with its characteristic fossils; but though 5′ thick, very little of it is fit for burning. being highly siliceous. It so shows on the Miller farm, but nowhere else has it been noted, and its sandy condition at Hoffman's marks its gradual passage into sandstone, which is its form eastward, not only over Pine Creek twp. but throughout all the region bordering on the upper Sandy Lick waters.

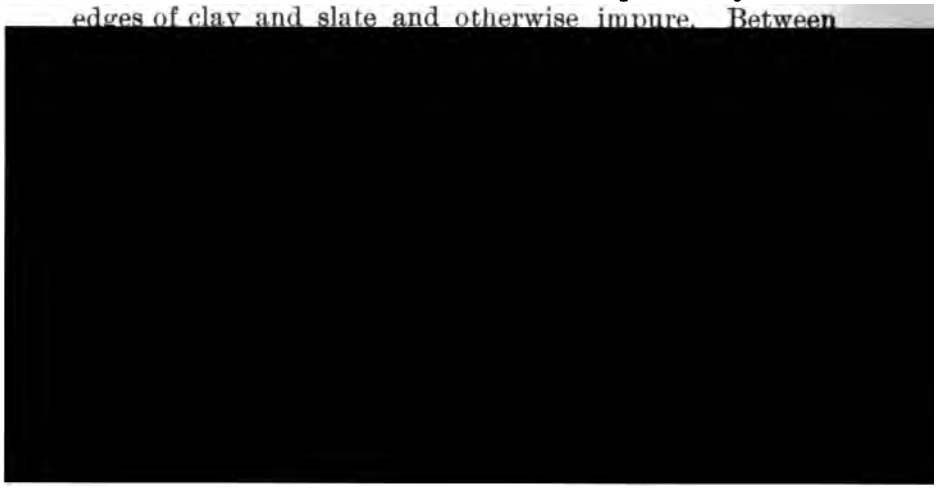
In Warsaw bed B occurs along Hemlock run 37′ above the Ferriferous limestone, measuring 2½′ at its best. The limestone has been repeatedly exposed east of Petersburg and quarried to some extent as a fertilizer on the Temple farm and the Raught farm, nearly 5′ thick of stone supporting a thin layer of the Rubrstone iron ore. At Mayerville the coal



finally on the Bullers farm, overlooking the stream at Hetrick's saw mill. Northeast of this locality there is none of this rock in the township. Probably the most complete exposure of it is at F. Schaffner's, where it shows a compact rock of excellent quality for burning, easily quarried and quick to calcine; slightly fossiliferous, dark grey, and with a rough face at the outcrop similar to that which it almost invariably presents. Indeed it is the most valuable key rock to the geology of all northern Jefferson county although it is frequently wanting in localities where its horizon is reached. (For sections of this coal and limestone see plates 441, 442 and 443.

Brookville coal A and Clarion coal A'. In Porter township these coals have but little range, being confined to the valley of Pine run. The Clarion coal A' is nowhere exposed and the Brookville bed A shows 1' thick on the J. Elkins farm, above the mouth of the Middle Branch. In Oliver, bed A was noted in the Big Run valley, mined on the William Newcome property, 60' below Ferriferous limestone and 2' 10" thick. It is also opened on the Hanna and Swab farms, but nowhere thicker, and on Little Sandy it shows 3' thick on the Hurl farm. In Beaver however, this coal attains workable thickness over all its outcrop area, and becomes one of the principal sources for fuel. Along the Reitz Run branch of Ferguson run it is 4' 10½" thick as mined by Mr. Hetrick, with 1½" of slate, its lower bench here showing 4' 1" to 4' 3" of coal, but always slaty. In the next ravine west it has been opened in a number of pits with very similar section, in one opening abnormally developed to a thickness of 7'; but 4½' is a fair average section in this township. It is 4' on the Boyer farm and 5' at E. Thomas', near Zion church. The Clarion coal A' shows 1' thick around Pleasantville; but the Brookville A is everywhere 4' thick and sometimes thicker, though the coal is generally poor and the roof often leaky. On the Brocius farm, near the Rose township line, it is again 4' thick, and here 95' below the Ferriferous limestone instead of 65', south of Beaver run. (Bed A on plates 441, 442 and 443.)

In Clover it is also largely worked. At Troy on Red Bank, above the mouth of Welch run, it shows 3′ 6″ on J. Smith's land, with 1″ to 3″ of slate about a foot from the roof, and from 70′ to 80′ below the Ferriferous limestone, which rock is exposed in many pits and quarries on both sides of the creek, always good and averaging 4′. On Welch run on the J. Ross farm bed A shows 3′ 0″, parted 8″ below top by 3″ of slate. On Knapp run the coal is so slaty and pyritous as to cause its entire abandonment in favor of bed B, although reported 4′ to 5′ thick at Shields', Kelso's, and Magill's. In Rose the Brookville coal A and Clarion A′ are best exposed in the Red Bank valley at the pottery of Messrs. Newsome, Porter & Co. The former is pyritous and slaty and 3′ thick. The Clarion A′ is 25′ above bed A, but only 8″ to 30″ thick. West from Brookville, on the Corsica road, bed A is only 18″ and A′ 1′ thick; but on Coder run the former was once opened on the Snyder property 5′ thick. North of Brookville, on the Sigel farm, it is small and unimportant. In Pine Creek, along the North Fork north of Brookville, bed A is opened on the J. Hoffman farm 2′ 2″ thick. It carries 7″ of cannel slate on top, and 1″ of bone coal parting beneath the upper bituminous bench of 11″, leaving 7″ of coal in bottom. It is thin, but about the best the country affords; both A′ and B are thin here. At W. Carberry's, 1 mile north-east, bed A shows 3′ 2″ to 3′ 6″ thick, but parted by knife edges of clay and slate and otherwise impure. Between



all things, it is beyond comparison the best seam exposed in this township. In Snyder this bed was twice observed. Scarcely any developments have been made upon it, because it hardly repays attention whenever other seams can be obtained. It outcrops in the Little Toby road near J. A. Adams' house. It has been opened on A. Shorts' lands about 2 miles north of the Episcopal church, where it measures 3′ thick; and it is the only seam caught in the hills about the headwaters of the North Fork.

In Barnett, Heath and Polk twps. along the northern end of Jefferson Co. comparatively few of the hills rise high enough above the Homewood sandstone to contain the lowest coals of the Allegheny River series. Around Schaffner's Corners the most noticeable change in these measures from their typical condition elsewhere is the presence of the Clarion coal bed directly under the Ferriferous limestone, the Brookville coal being in the position usually occupied by the Clarion, 35′ below the limestone. Or we may interpret the case differently, and call the upper coal the Scrubgrass, the lower seam the Clarion, and erase the Brookville from the series altogether. In few of the sections made elsewhere in adjacent townships the latter interpretation is less likely to be correct. The Brookville coal is the most important seam in the region around Schaffner's Corners. All the beds are small and this one scarcely larger than the others; but it appears to be the best coal. On W. L. Smith's farm at the southern edge of the township it is 2′ thick; at W. Wingerd's, north of Schaffner's Corners, it is 3′ thick, but slaty. The Clarion coal is unfailing beneath the limestone but always too small to mine unless it would be taken up with the rock and used for calcining.

*No. XIII in Indiana County.**

With the exception of five points in this county, in the principal creek gaps, and four other points along the ant

*Throughout this report Mr. Platt recognizes the *Freeport Group* as double; but he calls the *Lower Freeport coal*, "Bed D," and without other name; the next lower (*Upper Kittanning*) coal, "Bed D."

clinical axes, the entire area is occupied by the coal measure rocks. The continued general sinking to the south-west has however largely concealed the *Lower Productive Measures* of Jefferson Co. beneath water level in Indiana, while that movement has not progressed sufficiently to bring into the hills the *Upper Productive Measures* except in the extreme south-west corner, along the Armstrong Co. line. Hence over three-quarters of the 830 square miles in this county expose the intermediate *Barren Measures* as the surface rocks.

The Laurel Hill axis merely touches the extreme south-east corner of the county in the Conemaugh gap, beyond which and westward the *Ligonier Valley basin* occupies a triangular wedged-shape area to the Chestnut Ridge axis, sub-divided however by a sub-ordinate axis running through Nolo and Kimmel. Both sub-basins are filled with *Barren Measures No. XIV;* but the *Allegheny River coal series* crop out along the valleys which follow or cross the anticlinals. The Indiana axis extends as a straight line nearly through the centre of the county with the *Blairsville basin* on the east side and the *Marion sub-basin* on the west, separated from the *Saltsburg-West Lebanon basin* along the Armstrong line by the Saltsburg or Perrysville axis, which expires north-eastward in Rayne twp.

Limestone is very abundant in the county, for besides five such strata in the *Barren Measures*, there are six

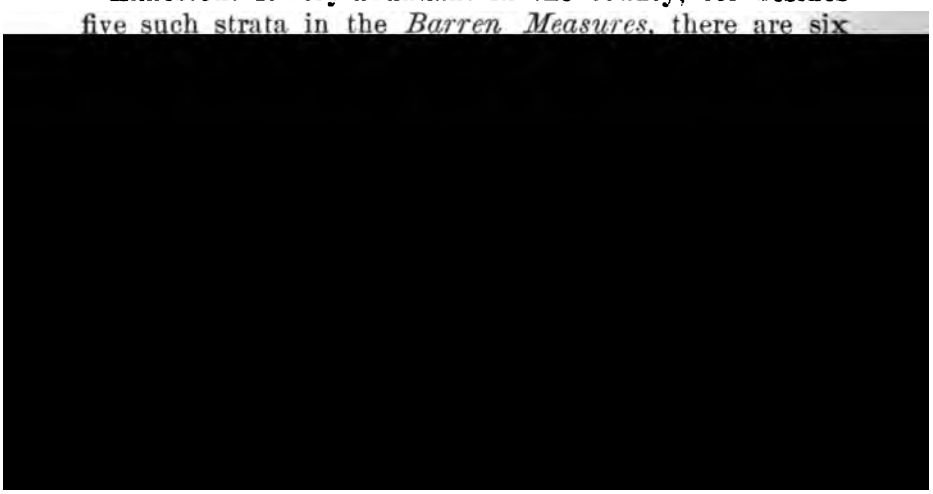
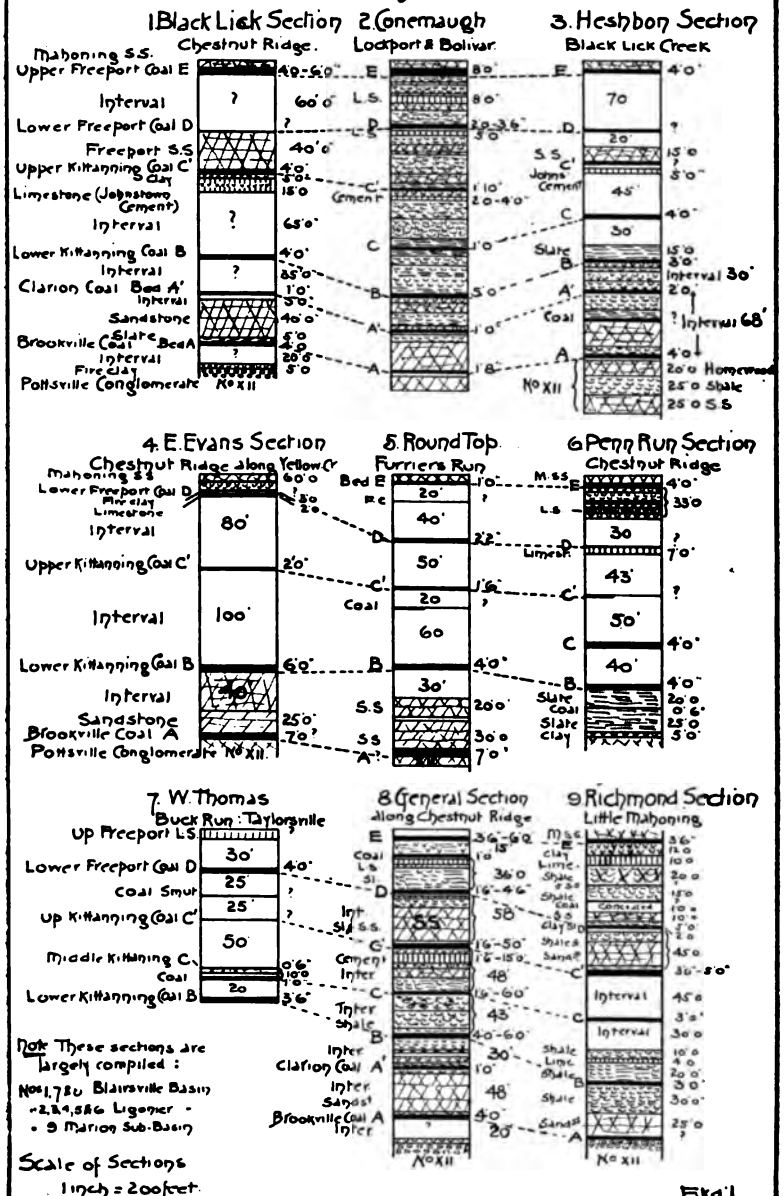


PLATE 444.

No XIII Allegheny River Coal Series in Indiana Co

Vertical Sections of the Lower Productive Measures





though everywhere conspicuously a key-rock of importance in the more western and northern counties. The coal beds of the series will be mined in the future mostly by shafts, although there are still large and important areas of them above water level along the larger creek valleys of the county. Some of the characteristics of these coals and accompanying rock strata are given in the order of the several basins, from the east westward. Vertical sections of the measures are given in plate 444.

*No. XIII in the Ligonier Basin.** The group is typically expressed along the Conemaugh river in the Ligonier basin, virtually as it shows in the *First* and *Second basins* east. This section is shown in figure 2, plate 444. The entire section, between bed A and bed E is about 300′ thick here as against 200′ in northern Cambria Co.

The *Brookville coal A* throughout the county is generally very impure from the association of large amounts of iron pyrites, varying greatly in thickness. At the old Conemaugh furnace it is 4′ thick and only 18″ at Bolivar, 10 miles down the Conemaugh river. On Black Lick, at Heshbon and Bell's Mills (where it is used for steam purposes and baking fire brick) it is between 3′ and 4′, and sulphurous. On Yellow creek it is reported to show 6′ thick and is not seen north of the Two Lick in Indiana Co.

The *Clarion coal A′* is everywhere thin and unimportant as a mining bed, but is very generally persistent and useful as a key-rock. The Ferriferous limestone is generally wanting in the Ligonier basin and it is doubtful if this horizon shows as limestone east of the Indiana axis.

The *Lower Kittanning bed B* comes generally about 75′ above bed A in the Ligonier basin, varying between 50′ and 100′. It is not a good seam in this basin, though almost invariably a large bed, generally impure and split nearly in half by a band of clay shale; but it is probably this coal that is found in excellent condition as it rises on to

* Plate 445 illustrates the varying section of the four principal beds in this basin.

the Laurel Hill axis, east side of basin, along Black Lick in Cambria Co. (See sections on plate 445).

The *Middle Kittanning bed C* lies 45′ to 50′ higher in the measures, and is a small seam of coal wedged in between black slates. It is seldom mined in Indiana Co. and is generally an unreliable bed.

The *Johnstown cement bed* is present in the Ligonier valley as elsewhere in Indiana Co., 2′ thick at Lockport but increasing north-east to 10′ on the Black Lick and becoming a conspicuous feature of the geology. In this basin it is quite free from impurities and is largely used for fertilizing. It is at least 100′ above the Ferriferous limestone (under bed B) with which it was formerly confounded, and everywhere underlies the now well known Upper Kittanning coal C′.

The *Upper Kittanning coal C′* (called *bed D* in the Indiana Co. report) almost immediately overlies the Johnstown cement. Thin on the Conemaugh, it is 4′ thick on Black Lick and remains one of the productive coals of the *Ligonier basin* going north-east. Its lower bench is usually a good and satisfactory coal; but more often the bed becomes highly charged with slate, greatly reducing its commercial value and in the western part of the field, changes to an impure cannel slate. (Sections on plate 445).

The *Freeport sandstone* is somewhat thin bedded along

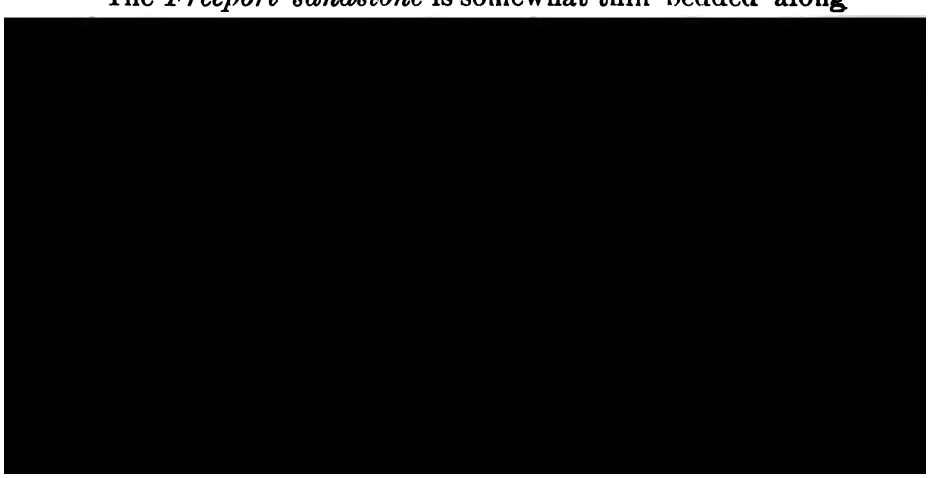


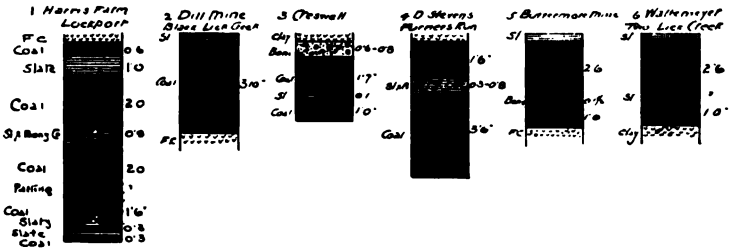
PLATE 445.

No XIII Allegheny Coal Series in Indiana County Pa

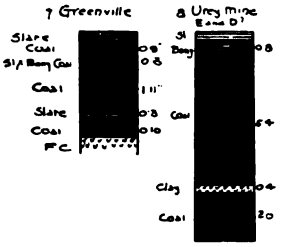
Coal-Bed Sections in the Third (Ligonier) Basin

Scale 8 feet = 1 inch

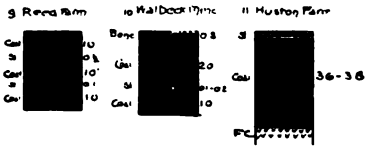
THE UPPER FREEPORT COAL OR LEMON SEAM BED E



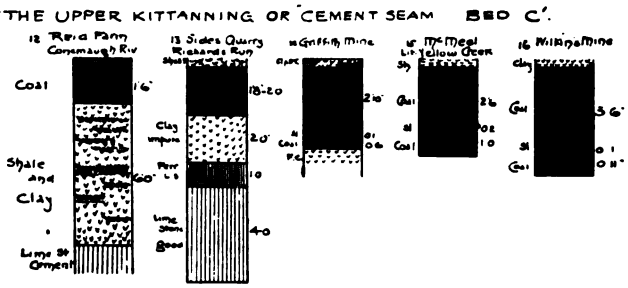
UPPER FREEPORT BED E



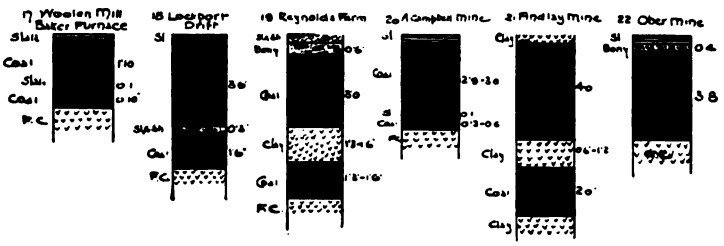
THE LOWER FREEPORT BED D ("Moshannon")



THE UPPER KITTANNING OR CEMENT SEAM BED C'.



THE LOWER KITTANNING OR MILLER SEAM BED B





ance in this basin and through much of Indiana Co. where lower beds are concealed beneath water. It rarely shows a bed of conspicuous good quality; but it is thick and more generally accessible and therefore of far greater importance here than along the Allegheny Mt. to the east. Whilst showing 8′ thick along the Conemaugh it carries two bad shale partings, characteristic of the bed north-east, though thinner, and is also seen to the west of Chestnut Ridge. In *Ligonier basin* this coal is generally of inferior quality as compared with the coals it must compete with in the open market; but some portions of the bed are very much better than others. (Plate 445).

At Lockport the two Freeport beds (E and D) and the Lower Kittanning bed B are all of workable thickness, together aggregating 15′ of coal. Limestone is also abundant, the *Lower Productive group* yielding 17′ and the *Barren Measures* as much. At Bolivar the fire clay is good and abundant. One bed occurs 15′ to 20′ below bed E; varies from 3′ to 8′ thick and "yields a smooth even clay quite free from impurities." The other bed underlies bed A, and on top of the Homewood sandstone as in Clearfield, Cambria and Centre Cos. The Freeport clay has been traced southward through the Ligonier basin into Fayette Co. and across the Youghiogheny into West Virginia.

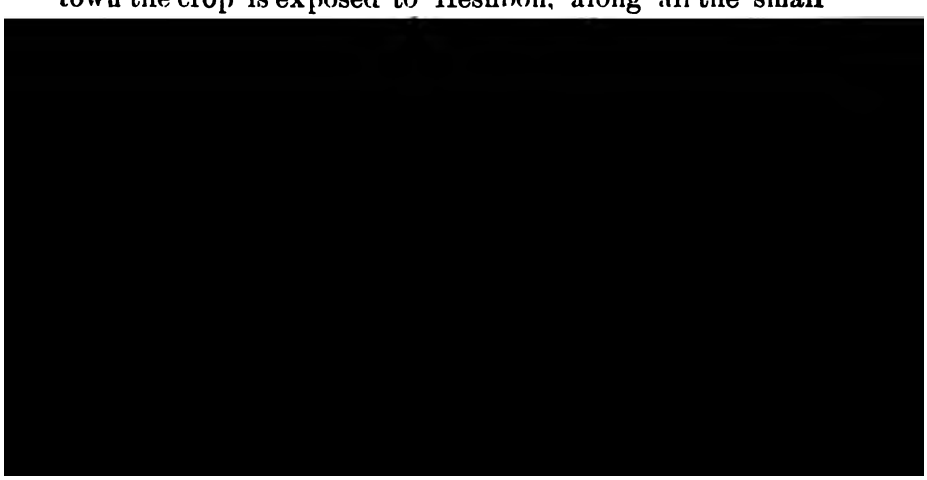
The entire series, with Mahoning sandstone above and No. XII below, are well exposed at Heshbon in the Ligonier basin (see figure 3, plate 444). They are a trifle over 300′ thick. On Yellow creek the average section is about the same as on the Conemaugh, the vertical interval between E and A being 270′ on the Evans farm as against 300′ at Bolivar. On Two Lick this group is well exposed at Mitchell's mills, in the gap in Chestnut ridge, the axis rising both northeast and southwest from here through Indiana Co.; and still better at the village of Greenville on Penn run to the southwest. On Cush creek, the group is present and largely opened, especially the *Lower Freeport coal D*, which occurs as a good mining bed in more or less detached areas

through all northern Indiana Co., in the Ligonier basin north of Gettysburg.

Freeport Upper Coal E on the Conemaugh and its Branches.

Extensively mined at Lockport both for steam and for making coke, although coke making has now been largely abandoned. It has been opened on a number of farms, and on the Harris property shows its typical section here (figure 1, plate 445). It is a triple bed, 8′ 3″ thick. The main middle bench is 3′ 6″ thick, with a very thin but persistent parting nearer the floor than roof. The upper bench is also 3′ 6″, with 1′ 0″ of slate only 6″ from top, and between these two benches occurs slate and bony 0′ 9″ thick. The lower bench is 3″ thick and separated from the middle bench by a 3″ slate parting.* The bed, though large, simply furnishes about 3′ 6″ of coal from its main bench, and whilst the upper 2′ 0″ of this bench is good (F. C. 71.900 ; V. M. 24.467%; S. .588%; ash 2.385%), the lower part is poor and slaty (S. 1.173% and ash 13.215%). Of course the lower portion is preferred for local use, merely because it mines out in blocks and bears transportation well; but the upper is much purer, whilst soft and friable.

On Black Lick, on the Ling farm, head of Laurel run branch, it is 3½′ thick ; base of Laurel hill. West of Dilltown the crop is exposed to Heshbon, along all the small



parted near floor by a small and persistent slate. It is slightly pyritous but yields a fairly good coal. But on the McMeel place this coal is only 20″ thick, in marked contrast to its sections in the Irish Bottom. On the lower Yellow creek, as the rocks rise to the Chestnut Ridge axis, it is also small on the Creswell property, directly beneath the Mahoning sandstone and shows: 0′ 10″ top, bony coal; 1′ 7″ coal; 0′ 1″ slate and 1′ 0″ coal; total 3′ 4″. It is here only about half as thick as on the summit of Chestnut Ridge, to the south-west of Round Top. At Evans neither this or bed D are opened. On D. Stevens farm it is 5′ 8″ thick, with a slate and bone parting 1′ 6″ from the top, varying from 3″ to 8″. It shows nearly the same section at the Overdorff, Findlay and Brown farms, from where it can be traced to Dearmy and Gamble's, where it shows its full thickness.

Along Two Lick creek it skirts both sides of the North Branch to its headwaters at the Dunkard church, though scantily developed. The principal openings are confined to the "Pleasant Valley" in the vicinity of Buterbaugh's mill, where it maintains an average of about 4′ as opened by Butterbaugh, Berr and Nickle. Buterbaugh's mine shows 3′ 7½″ thick, with 1½″ of slate 1′ from bottom. The other two mines show thicker and somewhat better coal although it may very well be that they are the Lower Freeport coal which gradually improves in character and section going north. Bed E shows on S. Meyers' farm, 1 mile north-east of Taylorsville, and close to the Chestnut Ridge axis, about 3′ thick. Here its limestone is 28′ lower in the section, showing 3 layers separated by bands of clay, in all about 6′ thick. It is exposed well up the hill at Mitchell's Mills near arch of axis and on the Waltemeyer farm one mile below, 3′ 6″ thick, with a knife edge of slate 1′ from bottom. At Greenville on Penn Run branch the Mahoning sandstone forms its roof and the bed is much parted by persistent bands of slate, having an average section of 4′, with two 3″ slates separating coal benches of 0′ 9″, 1′ 11″ and 0′ 10″. It shows similar sections to the south and west

and at I. Mentch's on the Strongtown pike 2 miles southwest of Greenville; whilst resembling the Homer section on Yellow creek, the whole bed is here thinner.

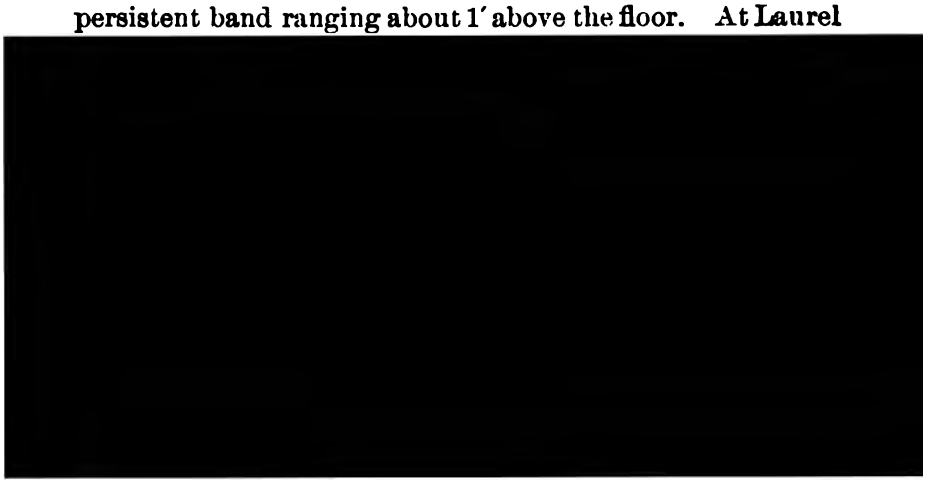
Along Cush creek and Bear run, east of Chestnut Ridge, bed E is little known; but it seems to be represented in the *Urey bank*, at the head of Bear run, many think here in connection with bed D, showing an enlarged section as follows:—

Coal,	2′ 6″		
Slate,	0′ 3″	4′ 5″	Upper Portion. Bed E?
Coal,	1′ 8″		
Slate parting,	2′ 6″		
Bone coal,	0′ 10″		
Coal,	5′ 2″		
Slate,	0′ 4″	7′ 6″	Lower Portion. Bed D?.
Coal,	2′ 0″		

At all events the Urey coal is an unusually thick individual seam, capping the hill in a long slender outcrop, containing coal of great purity and value to the neighborhood. Both benches yield equally good coal and the whole section presents a superb appearance. (Figure 8 plate 445.)

Lower Freeport coal bed D in the Ligonier basin.

At Lockport it shows 2′ thick along the railroad and 3′ on the Reid property, opened 40′ below bed E. It yields an indifferent fuel much intermixed with slate, one thin persistent band ranging about 1′ above the floor. At Laurel



Round Top, near summit of Chestnut Ridge, it occurs about 60′ below bed E and about 2′ thick. On Two Lick, it may be the "*four foot bed*" opened on the headwaters of the North Branch, as on the Chestnut Ridge axis 1 mile north-east of Taylorsville it shows 3′ 6″ to 3′ 8″ in one bench on the Huston and Nupp farms. At Greenville on Penn run it is beneath the surface; but 2 miles south-west along the pike it shows as a very thin seam at I. Mentch's with its underlying limestone 7′ thick.

Along Cush creek and Bear run, the *Lower Freeport coal D* becomes of paramount value and importance north of Gettysburg in Montgomery and Banks twps.* along the waters of Cush creek and Bear run as it approaches the magnificent fields around Punxsuatawney in Jefferson Co. This coal is now splendidly exposed along the headwaters of both branches of Cush creek and is mined commercially on both McCoy and Graham's runs by Messrs. Passmore, Campbell and Reakirt. The bed first appears above water on Cush creek in Clearfield Co., cropping along the Susquehanna river well above Burnside. At Gardner's mine, on the south side of creek, it shows top bone 0′ 10″; slate 0′ 3″; coal 0′ 10″; slate 0′ 3″; coal 2′ 0″ or a total mining section of a little over 3′. At Elijah White's higher up on same side, the whole section is over 4′, with top bone 0′ 6″, coal 1′ 0″ to 1′ 2″; slate 0′ 2″ and bottom coal 2′ 4″. Both these openings are in Clearfield Co., the coal cropping up the stream and rising rapidly to the Chestnut Ridge axis at Smithport.

The McMaster's bank, just in Indiana Co. on this hill, to the north of the creek, shows the coal bed 4′ 7″ thick, here with two slate partings of 3 inches and 4 inches and three coal benches 1′ 6″, 1′ 6″ and 1′ 0″ thick. The Suter bank of the Glenwood Coal Co. is being operated on Suter branch just above Cush creek, starting with 4′ 3″, carrying 6″ of top sulphury coal and 5″ of slate and bone; but in the mine

*Some operators still claim this bed is Bed C′, opened at many places since Mr. Platt's report was written, owing to the extension of railroads here; but this is hardly likely to prove correct.

rising to over 5′ of good coal. Just opposite Cush creek receives the waters of McCoy's run, Brady run and Graham run, with railroad branches laid on the first and last creeks, developing the two Passmore mines and the Graham branch serving the Reakirt and Glenwood mines. They all work the same bed, making two separate areas cut by Brady's run. The old Shephard bank, facing Brady's run on the west side, shows the coal 5′ 1″ thick as follows: top coal 0′ 4½″; bone 0′ 2″; coal 0′ 7½″; slaty coal 0′ 3″; bottom coal bench 3′ 8″. The Graham bank of the Glenwood Coal Co. is at the head of the right fork of Graham run and shows bed D 4′ 6″ thick, without parting. The Reakirt mine (Patchen bank) is at the head of the left fork, and shows bed D 5′ thick, with 2″ of top bone and 2″ of a bony parting separating a top and bottom bench of 2′ 6″ and 2′ 2″.

To the north the outcrop is cut out by the branches of Brady's run, but catches again in next hill along the road north-east of Smithport, on the summit of the Chestnut Ridge axis, where the Deep bank shows 4′ 9″, with 4″ of top bone, 3′ 6″ coal, 2″ slate and 9″ bottom coal. Another small patch of coal occurs just west of Smithport, and a second one east of the village at the head of Fuller run, where the coal is opened 4′ thick at the Rawley bank, 3′ 8″ of good top coal, 1″ slate and 3″ of bottom coal.

South of Smithport, along the Gettysburg road, there is an irregular patch of considerable size between the north

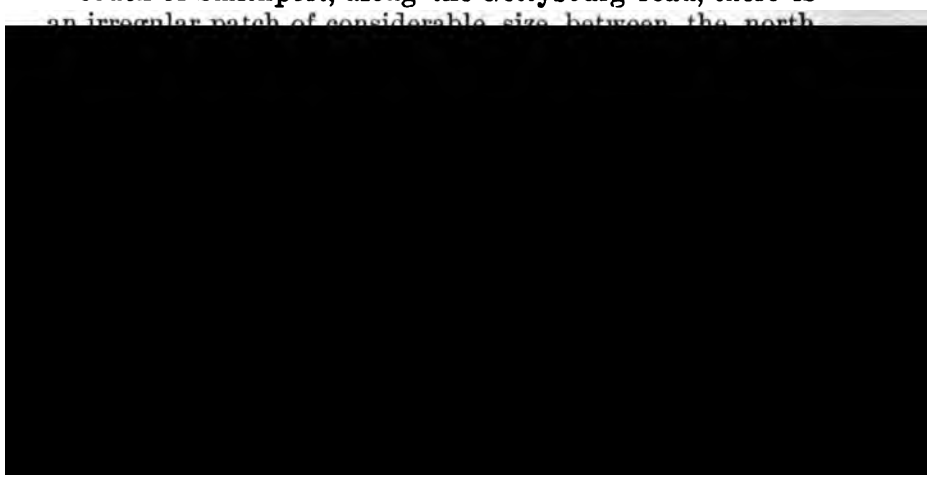
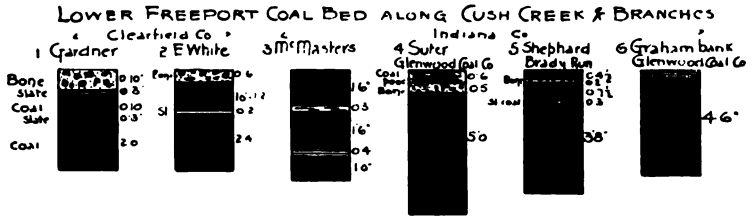


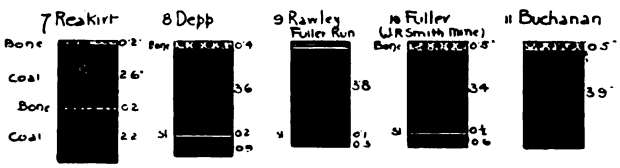
PLATE 446

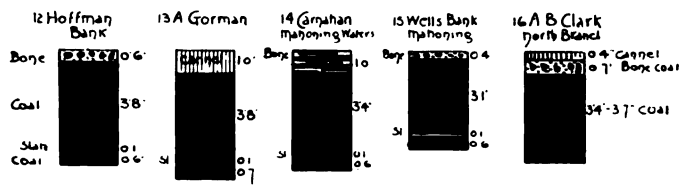
No XIII Allegheny Coal Series in Indiana Co Pa

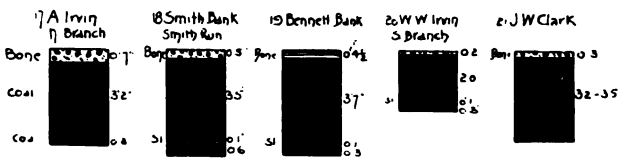
Coal-bed Sections in north end of Blairsville B.[illegible]

LOWER FREEPORT COAL BED ALONG CUSH CREEK & BRANCHES









Scale 1" = 8'

EV D1.



Gorman's run cuts out the coal here; but another area increasing in width southward, extends along the public road, west of the North Branch south to Gettysburg, there to join the large area between the branches of Cush creek, to extend solidly through eastern Montgomery twp.

The Jas. Gorman opening is the first met with on the north, showing at the head of a small branch of the Little Mahoning creek nearly the same section and character as Alex. Gorman, and underlaid by limestone, which led to the bed being considered C'. The coal is opened southward at several points facing the Mahoning waters; at Carnahan's, W. G. Walker, Wells and Spichers. At the first it is 4' 10" thick, the top foot being bone and dirty coal, then 3' 4" of coal, 1" slate and 6" coal. Walker shows nearly same section. Well's bank 4" of top bone, 3' 1" coal, 1" slate and 6" coal.

Descending the North Branch of Cush creek, the A. B. Clark mine shows on the west side about 2 miles north of Gettysburg, 4" of top cannel and 7" of bone, the bottom good bench being 3' 4" to 3' 7" thick. Alex. Irvin's bank opposite shows 7" of top bone, 3' 2" good coal and 3" of poor bottom coal. The Smith mine lower down stream on same side, facing Smith run, shows 5" of bone top, 3' 5" good coal, 1" slate and 6" bottom coal. The Bennett bank at the forks shows top bone 0' 4½"; good coal 3' 7"; slate 0' 1"; coal 0' 3". The south branch of Cush creek shows bed E at W. W. Irwins bank only 2' 6", with top bone 0' 2", good coal 2' 0"; slate 0' 1" and coal 0' 3". But opposite the coal shows 3' 10", with 0' 5" of bone coal on top and at J. W. Clark's mine, 3" of bone and 3' 2" to 3' 5" of good coal before passing under water level. The Lower Freeport coal bed therefore in this district has in detail a somewhat variable section; but it will average between 3' 6" and 4' 0" of mining coal of excellent character. (For coal bed sections see plate 446.)

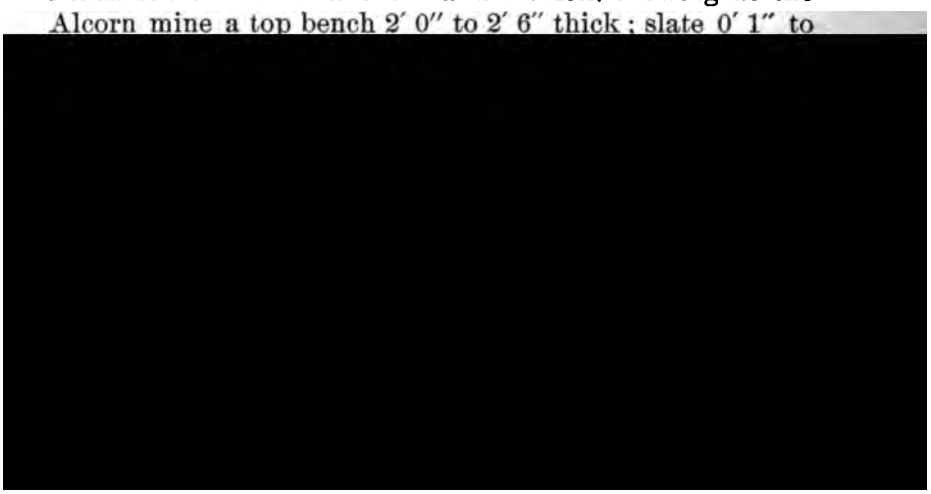
The Kittanning group in the Ligonier Basin.

The *Kittanning upper coal C'* is not important on the Conemaugh, opened 18" thick and 65' under bed D.

It shows the same section in the German settlement on Richard's run; but near the head of the valley at the Gamble opening, it showed nearly 3′ parted by 1′ of shale. It is 45′ below D and 50′ above C. The *Johnstown cement* rock is important in this valley, composed of good limestone 4′ to 5′ thick, the top 1′ poor, ferriferous, and 2′ under C′. At Heshbon on Black Lick it furnishes good limestone upwards of 5′ thick. The overlying bed C′ seems to be thin.

At Griffith's mine, near headwaters of the main Yellow creek close to the Nolo axis, the coal is 3′ 5″ thick with 1″ of slate 6′ above floor. On Little Yellow creek it is 3′ 6″ thick at Gillespie's mill, and opened also by Cresswell and NcMeel; at the latter place 3′ 8″ thick with 2″ of slate about a foot from the floor. The Johnstown cement does not show here. On the J. A. Wilkins farm, on west side of basin, it shows 4′ 6″ thick, with a top bench 3′ 6″ and a bottom bench of 11″ and 1″ of slate between; but its average section in this region is about 3′ 6″ only. It is scarcely known on any of the branches of Two Lick to the north. (For sections see plate 445).

The *Kittanning middle coal C*, at Baker furnace on the Conemaugh, is 2′ 6″ thick. At Lockport it is 5′ 3″ thick in two benches; upper 3′ 6″ and lower 1′ 6″ with parting of 3″. Its coal is impure and but little used. At Heshbon on Black Lick it is 45′ above B and 4′ thick, showing at the Alcorn mine a top bench 2′ 0″ to 2′ 6″ thick; slate 0′ 1″ to



at Lockport with its parting it measures 5′ thick. It shows the same section ascending Laurel run at Reynolds', parted by a thick band of impure fire clay. The bed here is both pyritous and slaty, especially the lower bench. On the Brendlinger place on Laurel it carries 6″ bony top coal; upper bench 3′; clay parting 1′ 3″ to 1′ 6″; bottom bench 1′ 3″ to 1′ 6″; total 6′ 6″. It is just above water level at the mouth of Richards' run next east.

At Clark's mine on Black Lick, head of Laurel Run branch, it is 4′ thick, parted by a thick band of clay and formerly mined for Black Lick furnace. At Heshbon it is 3′ thick, mined by A. & S. Campbell and M. Wayner. In all these mines it is parted near the floor by a thin slate and yields a tolerably good coal, esteemed above all others in this region. The top bench in A. Campbell's mine varies from 2′ 9″ to 3′ 0″, slate 1″ and bottom bench 3″ to 6″, total 3′ 7″. (For sections of this bed see plate 445.)

On Yellow creek, on Evans farm, near centre of Chestnut Ridge anticlinal, it shows a section similar to that at Bolivar on the Conemaugh and at Parkerfields west of the ridge. It is under water on the upper part of the creek, but at Fettermans on the Chestnut Ridge slope it is partially opened. It is reported to exist as a double seam, parted by a thick slate; but here only its upper bench 3′ 8″ thick is exposed. On the E. Evans farm its complete section shows, 4′ 0″ of top coal, 0′ 6″ to 1′ 2″ of hard clay and 2′ 0″ of bottom coal; total 7′ 2″. Both benches are impure through containing iron pyrites. Sandstone makes the roof and this opening is no doubt the same as the Findlay mine.

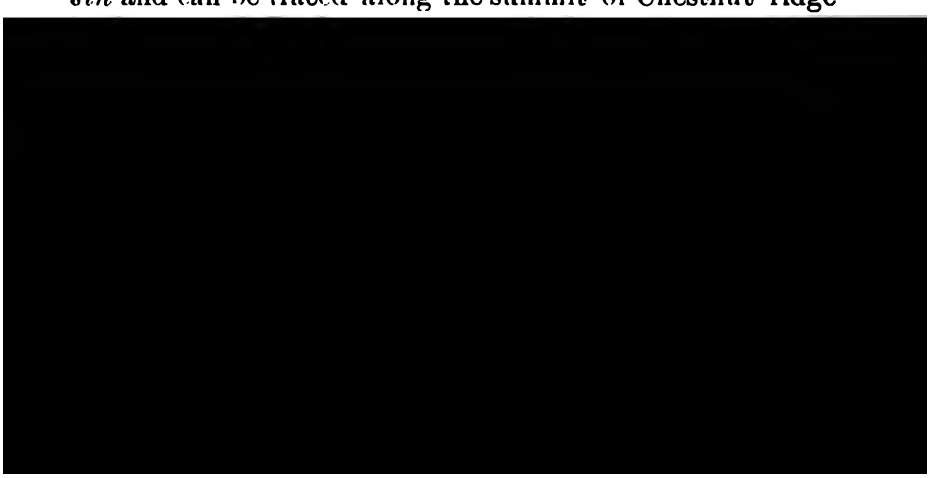
Near water level close to the Chestnut Ridge anticlinal this bed is believed to be the coal opened 190′ below bed E on the Roberts, Lewis, Findlay and Brown farms, although it shows about 4′ thick, capped with sandstone and believed by some therefor on this account to be bed C′. Its identification remains uncertain, the more so as a lower coal, in the gap, believed formerly to be A is now generally regarded as bed B, 7′ thick, parted near centre by a

heavy clay slate. On Two Lick it is largely under cover except in the gaps of Chestnut Ridge at Mitchell's mill and west of Greenville on Penn run. At the latter place it is thought to be the coal opened by Messrs. Stewart and Ober, where it is 4′ 0″ in one bench, of which the top 0′ 4″ is bony, and the main bench pyritous.

Brookville A and Clarion A′. Bed A is said to have shown 4′ at Baker furnace. At Bolivar it is only 18″ to 20″, mined in conjunction with the underlying fire clay bed. At Heshbon on Hoskinson's land bed A is 4′ thick parted near base by a slate 1″ thick. A′ here is 1′ thick, 65′ higher.

No. XIII in the Blairsville Basin.

The general section of the *Lower Productive Coal Measures* in this basin is quite identical to that in the Ligonier basin. It should be mentioned however that not a trace of the *Ferriferous limestone* was anywhere found in this basin, the exposures of this rock being confined to the territory *west* of the Indiana axis in the *Saltsburg basin.* In the same manner it should be remarked that just as this valuable key-rock to the geology of western Pennsylvania thins away along the Indiana axis, the overlying *Johnstown cement* (under bed C′) becomes distinctly prominent, cropping again and again along all the principal streams in the *Blairsville basin* and can be traced along the summit of Chestnut ridge



nut ridge. A general section of the whole group in this basin is given in plate 444 fig. 8, and bed sections of the two Freeport and two Kittanning coals on plate 447.

*Freeport upper coal E in the Blairsville Basin.**

On Tom's run, on the Livengood farm, it is exposed close to where its outcrop line touches the creek. The coal bed is soft, bright, of columnar structure and apparently free from impurities. The bottom bench is not here exposed, but is probably small. The upper bench is 3′ 2″ thick, with a small but persistent band of bony coal near the base. Beneath is a slate parting 0½″ to 1″ thick, and beneath the lower bench, 5′ of clay and 3′ of limestone; bluish in color and filled with impressions of minute shells.

On the Snyder farm on Tom's run, bed E is exposed, roofed by a cliff of the Mahoning sandstone. The coal is 3′ 7″ thick with a 1″ slate parting beneath the upper 3′ bench; but the bed is in superb condition here, yielding a coal of unusual purity, evidently local, to judge of exposures further north. The main bench shows F. C. 67.537%, V. M. 27.800%, Sulphur .718%, Ash 3.175%. But at Ragar's mine, on Wier's run, 1 mile north-east, where the bed shows about the same section the same bench carries over 10% of ash. It crops on Wier's run as far as McGeary's house, past Aber's to the Black Lick valley, much increased in thickness by a bad slate parting.

On Black Lick creek bed E shows in isolated knobs in Chestnut Ridge gap, principally on the S. Palmer farm, where its increased thickness is first manifested. The whole bed is 6′ 3″ thick, but the top 6″ is bony coal under a sandstone roof; thin slate and clay 0′ 6″; coal in main bench 3′ 9″ to 4′ 0″; slate 0′ 3″; coal 1′ 0″. This section is quite different from exposures on Tom's run and Weir's run, but partakes strongly of the character of this bed in the Homer region. Along the Indiana Branch this coal has been ex-

*For vertical sections of this bed in this basin see plate 447.

tensively mined by the Indiana and McCreary Coal and Coke Cos. at Graceton and Ransom stations, and coked to some extent.

On Two Lick, at the Lutheran Church, the coal has been opened in the Zach farm. The bed is 6′ thick; but it carries a large slate parting about 1′ from the roof, virtually reducing the bed to 4′, and rendering the upper bench worthless to mine. As on the Conemaugh at Bolivar, this great parting of clay and slate is the most conspicuous and destructive feature of the Upper Freeport coal in the Homer region. Moreover the seam here yields very little good fuel. Above the parting the coal is mainly a sulphurous cannel slate. A small zone near the middle of the lower bench yields excellent coal; but manifestly this band cannot be separated with profit in regular mining. The coal in this basin also carries an increased percentage of volatile matter On the Maxwell farm a partial section shows top coal 1′ 8″, clay slate 0′ 9″, coal 3′ 6″. The Mahoning sandstone is frequently the roof rock of the coal bed; but in this region it does not seem to affect the thickness of the upper bench whatever.

Along Tearing run the coal is below water level as high up the ravine as Coy's saw mill. On the Bracken farm the complete section is 6′ 8″ thick; but the mining portion is considerably lessened by the character of the several benches and partings, which from above downwards show: coal,



entire lower bench gave sulphur 1.177% and ash 6.450%. The Gable mine on the "Ridge" above shows practically the same section. Along Yellow creek this bed is frequently exposed, and always a double seam. It lies well for mining, especially southward to Tearing run; but its coal is decidedly inferior and badly parted for economical work. The Mahoning sandstone is found along the creek for nearly a mile above its mouth.

Bed E as exposed by Messrs. McDonald, Markle, Sheppard, Griffith and Porterfield is a double bed of uniform thickness, yielding about 6′ of coal, of which the lower bench gives nearly two-thirds. The following section at D. Griffith's mine is typical for the region: coal, upper bench 1′ 6″ to 2′ 3″; slate and bony coal partings 6″ to 9″; coal 4′, divided near center by a thin parting into two varieties and qualities of coal: the upper bench worthless; the upper part of the lower bench is an exceedingly good coal; but the lower part carries an excessive percentage of sulphur.

At Homer, in the bottom of the basin, bed E is 180′ below the surface. The St. Clair shaft on the south side of Two Lick, a little west of and in sight of the Indiana covered bridge, is said to have struck bed E in 60′, where it was found over 5′ thick.

The Agey bank, about 2 miles further up the stream, shows the coal in good condition and largely worked for local supply. The coal shows an average thickness of 7′ 3″. The top bench is 2′ 3″; slate parting 0′ 10″ and bottom bench 4′ 2″. Both benches are here mined, the lower bench the best and yielding sulphur 1.533% and ash 8.615%. Along Dixon's run this coal is little known although its outcrop can be traced nearly to the headwaters of the stream at Decker's Point. At the latter village the bed measured 5′, but includes much bony coal which reduces the mining thickness to about 3′. The coal is moreover impure, showing at the Beatty mine bony coal 1′ 4″; coal 3′ 10″ with a small parting 8″ above the floor. The main bench here gave sulphur 4.625% and ash 10.435%.

*Freeport lower coal D in the Blairsville Basin.**

The Lower Freeport coal D is thought to be the seam exposed near the head of Tom's run on the Thompson farm, where it shows a top bench under slate, 2′ 6″ to 3′ 0″; a slate parting of 1″ and lower coal 6″; total 3′ 7″. Also at Cobus farm 1 mile east, where it is a trifle thicker, its top bench 3′ 0″ to 3′ 2″, slate 1″ to 2″, bottom bench 0′ 6″ to 1′ 0″; total 4′ 4″. It is either this coal or C′ which shows further down Tom's run on the P. Brown property, underlaid by limestone 7′ thick; but the coal is here parted by a slate 6″ to 8″ thick, separating an upper bench 1′ 2″ from a lower bench 2′ 6″, in all 4′ 4″. While the total thickness here corresponds to the Cobus mine, the benches are different and the bed has been identified as D with some reservation. At Kerlin's the same bed is exposed; but the parting slate is only 3′ thick.

On Two Lick and Yellow creek waters it is a small and unimportant bed occurring about 60′ below bed E and usually accompanied by limestone. On the Griffith farm on Yellow creek its thickness is only 1½′; but north on Two Lick it is probably correctly identified on the Isenberg and Bennett farms in the vicinity of Porterfields mill 2′ 10″ to 3′ 0″ thick. On the Kellogg and Shearer farms it shows nearly 4′ thick near its outcrop, without visible parting, but carrying 2% of sulphur and 10% of ash.

Dixon run starts in rocks near the base of the Lower Productive coal measures and heads up northwards in the

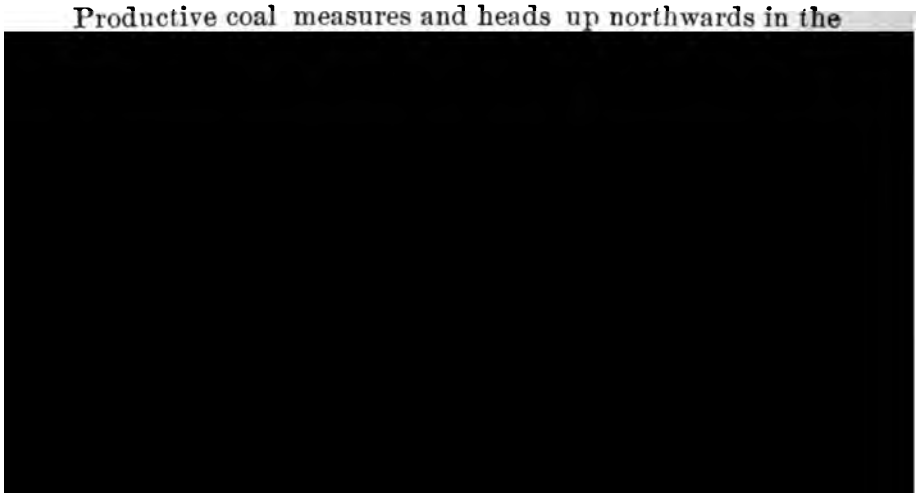
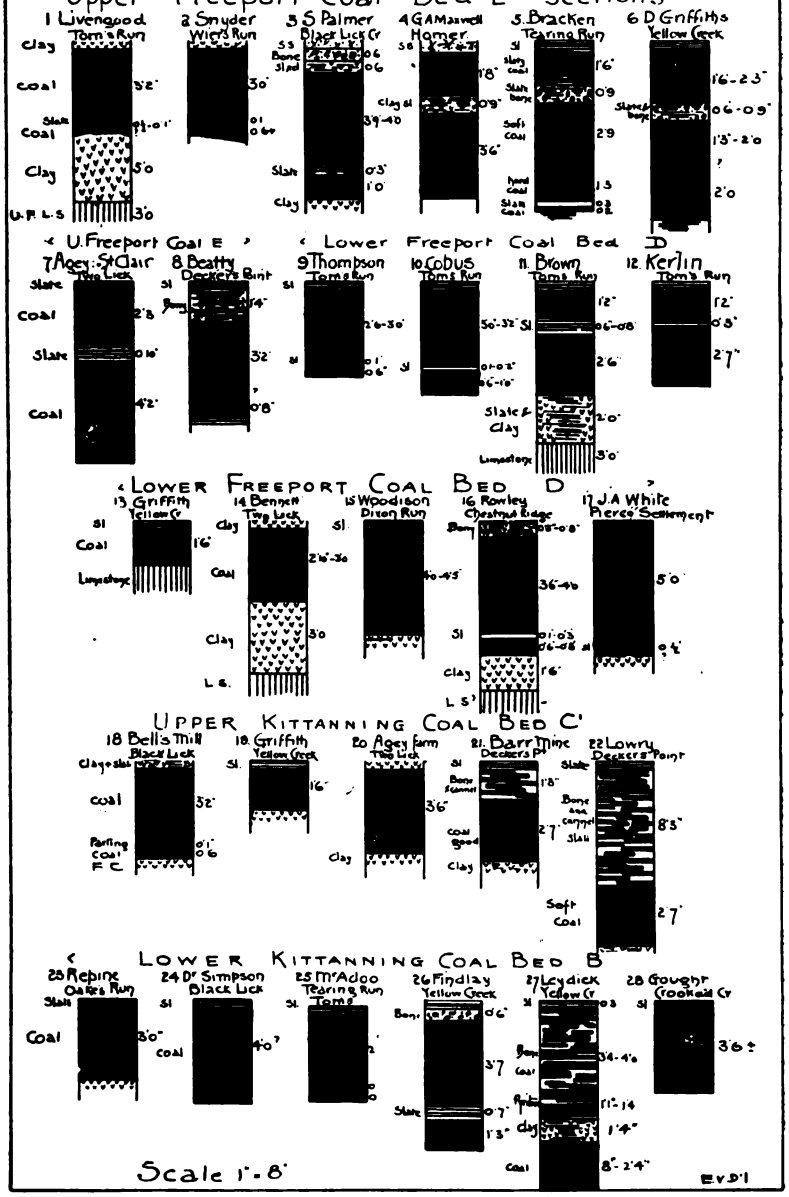


PLATE 447

No XIII Allegheny Coal Series in Indiana Co Pa

Coal-bed Sections in the Blairsville Basin Rep H4

Upper Freeport Coal Bed E sections





bench 4′ to 4′ 5″ thick.* The coal is somewhat tender, has a rich lustre and apparently free from iron pyrites. Towards Dixonville the coal is still good but only three quarters as thick. On the Buck run branch it shows the same section as at Woodisons, as opened on the J. Helman farms; also cropping through the M. Thomas farm.

The Freeport lower coal bed has already been shown to have a wide outspread in the upper Ligonier basin east of Chestnut ridge, along Cush Creek waters, usually a good 4′ to 5′ coal bed, characterized by one parting near base and often a few inches of top bone. Hence it is so identified as D in the Blairsville basin on Little Mahoning creek and branches, although Mr. W. G. Platt regarded it as an underlying seam (bed C′) in both basins. On the Rawley farm it shows 5′ 7″ thick on an average, separated by 1′ 6″ of bottom clay from a bed of limestone. As in the upper Ligonier basin east of Smithport, it carries 5″ to 8″ of bony coal on top; an upper coal bench 3′ 6″ to 4′ 0″; slate 0′ 1″ to 0′ 3″; coal 0′ 6″ to 0′ 8″.

On D. Stewart's farm adjoining, the bed is reported 4′ 6″ thick. Following along the crest of Chestnut ridge for nearly 2 miles it is again exposed on Wm. G. Walker's farm in the Ligonier basin, already described, where the section is like Rowley's.†

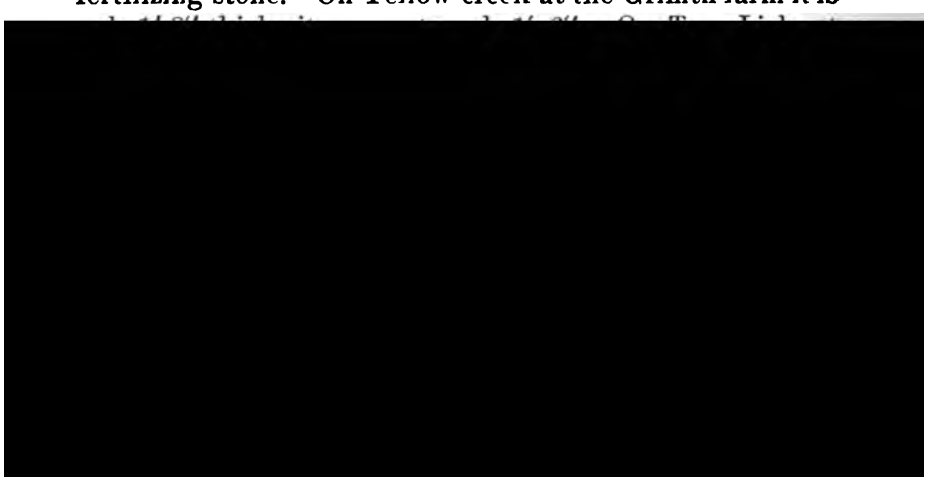
*On S. Barnett's farm, west side of valley, 200 yards above Two Lick the bed is from 4′ 0″ to 4′ 3″ thick. On the Weimer farm adjoining it shows clean 4′ 0″, yielding coal highly prized by blacksmiths. Back of Woodison's on the east side of the valley, the coal is opened on the Dougherty and Gibson places, showing over 4′ each. Further north on the Baker farm the coal shows 3′ 10″; the same at Shadrick. North of Dixonville 4′ 0″ is reported on the Reuben Black farm; but there are no further developments from here to Decker's Point. It is evident that there is a large and very accessible field of the Lower Freeport coal, with good thickness and quality, awaiting development for 6 or 7 miles along the Dixon Run valley.

†In the *Gorman Settlement* the same features prevail, and it was here that under the coal 5′ 2″ thick, Mr. Platt recognized a "ferriferous limestone" 10′ thick, separated from the coal by 4′ of clay, which he considered to be the *Johnstown cement* and from which he concluded that the overlying coal was bed C′, the *Upper Kittanning*. This may still prove true although all the Cush Creek operators, working the same coal bed, maintain it is the "Moshannon" bed D. About 5′ under this limestone Mr. Platt found another coal 3′ 0″ thick, which he named the "Gorman coal"

West of Washington, along the eastern slope of the Indiana axis, the same coal is worked south-west of the *Pierce Settlement* as far as J. A. White's, where the coal is again 5′ 0″ thick and again underlaid by the limestone (Johnstown cement?) which if properly identified would undoubtedly make this coal the Upper Kittanning. It holds its thickness down the north branch of Little Mahoning, past Tiger's to Widdowson's saw mill; up a branch of Straight run to State's farm where it measures 5′ thick. From Widdowson's to Richmond (where the creek cuts through the Indiana axis in rocks of No. XI) there are few exposures; but at Robertsville the same coal has been opened on the north side of the stream. At Decker's Point Mr. Platt reports it 2′ 2″ to 2′ 6″ thick, underlaid by 1′ 6″ of clay and 3′ 0″ of excellent limestone.

*The Kittanning Group in the Blairsville Basin.**

Kittanning upper coal C′. On Black Lick, in the Chestnut Ridge gap, this coal has been extensively developed by Barr and others, about 4′ thick. At Bell's Mills bridge it is 3′ 9″ thick with a 1″ parting 6″ above floor. It has a slate and clay roof usually; but the Freeport sandstone 40′ thick often lies directly on the coal. The *Johnstown cement* comes in 6′ below the coal, and is here 15′ thick, with small clay partings, portions of the deposit yielding good fertilizing stone. On Yellow creek at the Griffith farm it is



Mr. W. G. Platt, although many think the bed described as "bed D" (C') is in reality bed D, the *Lower Freeport*, connecting over the axis at Smithport with the many openings along Cush creek already noted; hence it is described under that heading in this report. Still at Decker's Point it shows its own characteristics, and as the Lower Freeport coal is opened above it 2′ 2″ to 2′ 6″ thick, there can be but little doubt that it has been correctly identified here on the Barr and Lowrey farms. At the former it shows 3′ 10″ thick, the top 1′ 3″ being bony coal and cannel slate. At the Lowery farm this cannel slate top swells locally to 8′ 3″, although the lower bench of soft pure friable coal remains 2′ 7″ thick as before. This cannel structure is very characteristic of the Upper Kittanning coal all through western Pennsylvania.

Kittanning lower coal B. On Chestnut ridge near head of Oakes run this bed is exposed as a patch of a few acres on Oakes Point, 3′ thick, where the outcrop of both A and C′ show limited areas. On Repine farm to the north-east, about 1 mile from the river, it again shows 3′ thick resting on clay and capped by slate.

On Black Lick it was opened by Dr. Simpson one mile above Bell's Mills, reported 4′ thick, without persistent slate partings, but yielding a rather pyritous coal. On Tearing run this coal shows 4′ of soft and inferior coal on the Bracken farm, a sample of it yielding 5% of sulphur and 7½% of ash. The Findlay opening, above the Sheelor bridge over Yellow creek, is believed to be on this coal, here locally called the "Seven Foot Seam" but showing bony top coal 0′ 6″; coal, top bench 3′ 7″; slate parting 0′ 7″, coal 1′ 3″, total 5′ 11″. It is utterly worthless coal, an analysis of the combined upper and lower benches showing F. C. 50.359%, V. M. 26.710%, sulphur 5.091%, ash 16.500%.

On Two Lick at Porterfields mill it shows 6′ thick, with like partings, on the McLean property, and of extremely inferior quality, in places overloaded with iron pyrites. Its top bench varies from 3′ 4″ to 4′ 0″, mainly bony above

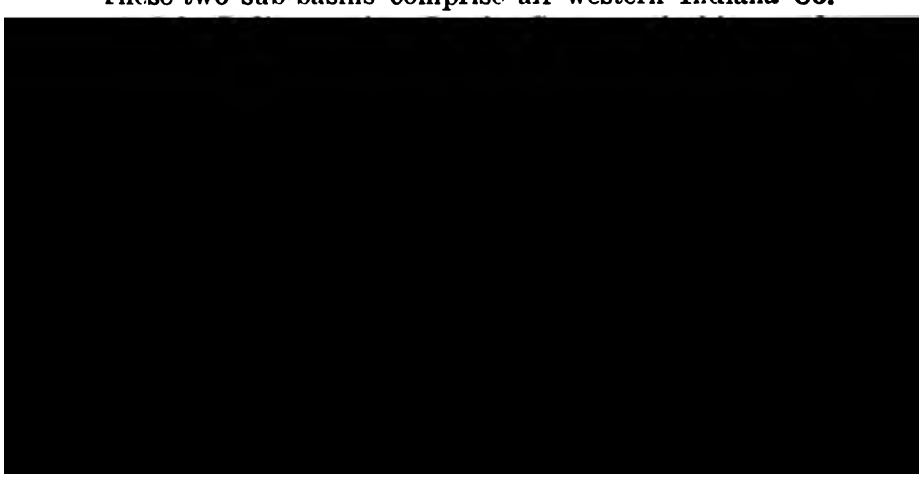
and pyritous below; parting 1′ 1″ to 1′ 4″ and bottom coal 0′ 8″ to 2′ 4″. At Hellman's pit, ½ a mile above Ramsey's run, it is somewhat improved in character, but still spoiled for mining purposes by a 2′ clay parting, separating an upper bench with columnar cleavage 3′ 6″ from a lower hard bench, with block cleavage 1′ 0″ thick.

Along Dixon's run this coal is not exposed; but on the Buck Run branch, nearer the Chestnut Ridge axis and heading towards Taylorsville, the coal is opened and mined close to water level on the Gought farm 3′ 6″ thick; at J. Mock's ¾ miles south-west and at D. Mock's.

The *Brookville coal A* is exposed in the Black Lick gap in Chestnut ridge above Dr. Simpson's mill, where it is reported 5′ thick parted by a thin band of clay. At Bell's Mills it has been worked by Mr. Mildren for the brick works and by Mr. Berry, showing a highly pyritous seam 3′ 2½″ thick, with 0½″ slate 2″ above the floor. An important bed of fire clay caps the *Homewood sandstone* here, about 20′ to 25′ beneath the coal, showing in two bands, the upper 3′ 0″ to 5′ 0″ thick, the lower 3′ 6″ with 1′ 0″ of sandstone and slate below. This deposit, when properly mixed, produces a fire brick with high refractory power and can be traced for some distance up the stream.

Marion and Saltsburg basins, Indiana Co.

These two sub-basins comprise all western Indiana Co.



North and West Mahoning twps.; in the beds of all the principal valleys crossing this *Fourth basin* of the First Survey; but except in the *West Lebanon district* on the south, where the *Pittsburg coal* occurs as already described, the entire trough is filled by the *Barren Measures*, beneath which the lower coals are buried, except as stated along the main creeks.

The *Lower Productive Measures* are little known in the southern ends of these basins along the Conemaugh; but north of the Purchase Line they occupy considerable areas above water. It is true that the Freeport group rises above drainage level at such points in the valleys of the Conemaugh, Crooked creek and McKees run, as lie close to the anticlinals; but the larger part of this entire field is occupied by *Barren Measures.*

*Freeport Upper Coal E-Marion and Saltsburg Basins.**

Along the Conemaugh bed E rises above the river between Kelley's station (Tunnelton) and Waddle's salt works, and rolling over the anticlinal again approaches water level near White station, describing an elliptical outcrop, 3 miles long. It carries near the floor a thin parting of bony coal and shows identically the same section here as at Jacksonville, 9 miles north-east, beyond which point it changes entirely to show on McKees run an important rider coal bench. Waddle's bank on the Conemaugh shows 3′ 9″ in all, with the thin bone parting 1′ above the floor. The seam is quite free from slate but carries an excess of iron pyrites. The Freeport limestone is 5′ below the coal, instead of the usual interval of 15′.

On Altman's run in the Jacksonville region, where the floor of the *Marion basin* has risen 300′, bed E is found in a small branch of Black Legs, 4′ thick on the Music farm and the same on headwaters of Coal run on property of Mr. S. C. Kennedy, where the section is similar to Waddle's mine on the Conemaugh, showing 3′ 11″ thick, with 3″ of bony and slate 6″ above floor, the bed capped with

*For sections see plate 448.

sandstone. Hazlett's mine at the mouth of Coal run shows the same section; but while the coal contains only slightly more than ½% of sulphur, it carries 15% of ash. This bed has been opened again on the Jack, Fails and Orr properties, higher up Altman's run, nearer the Saltsburg axis, and on branches of this stream on the Stewart farm and Clawson property. It is the only workable coal above level on these upper waters of the creek and is easily detected by its proximity to the Mahoning sanstone, which is very prominent at some places.

On McKees run, where the Saltsburg axis crosses at McKees mill, the Upper Freeport coal is exposed for about ½ a mile, always close to water level, dipping in opposite directions on the Stuchart and Craven farms. The coal here carries a rider at a short interval above the main bench, characteristic of this seam also on Crooked creek and on lower Two Lick and Yellow creeks.

On the Stuchart and Craven places an average section shows, (capped with Mahoning sandstone) an upper bench 2′ 0″ to 2′ 2″; clay parting 0′ 8″ to 1′ 2″; coal, lower bench 3′ 4″ to 4′ 0″. The Kinghorn bank, on the east side of axis probably, shows upper bench 2′ 0″; bony coal 0′ 2″; slate parting 1′ 4″; lower bench 4′ 2″. Frequently the lower bench carries about a foot of hard lustrous coal at the bottom, breaking in blocks and showing plates of pyrites. Commercially neither bench is good; the top coal, even without its bench of bony, carries sulphur 8.452%

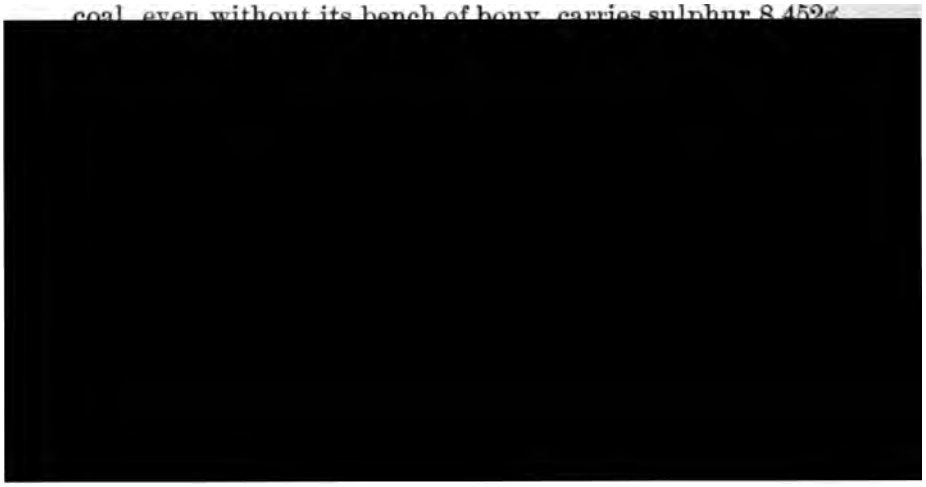
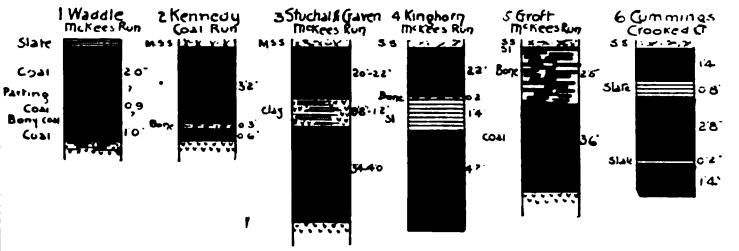


PLATE 448.

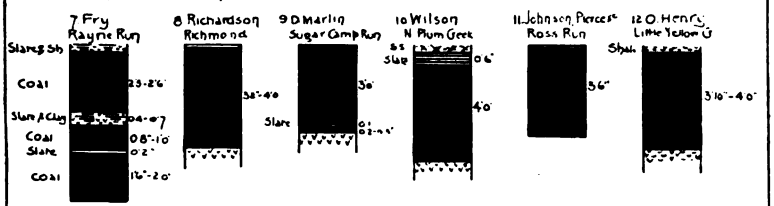
No XIII Allegheny Coal Series in Marion-Saltsburg Bs

Coal-bed Sections in Indiana Co Report H4

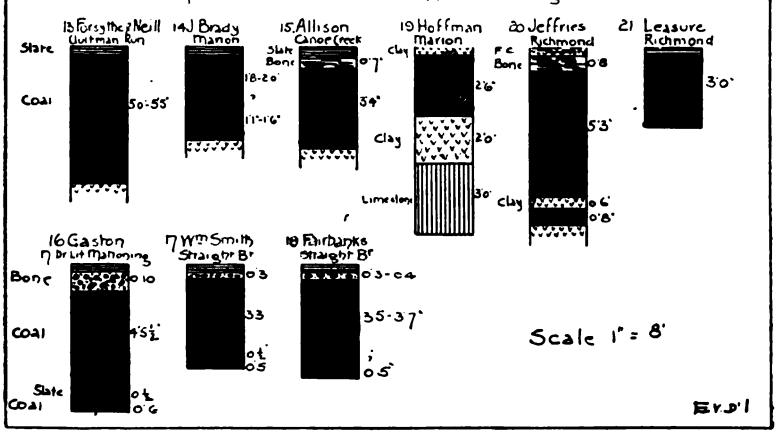
Upper Freeport Coal Bed E · Vertical Sections.



Upper Freeport Coal Bed E · Vertical Sections



Lower Freeport Coal Bed D · Upper Kittanning C · Bed B



Scale 1" = 8'

E.V.D.



sulphur 1.215% and ash 11.200%, which does full justice to the bed. The Cummings bank is the nearest opening to Chambersville, the coal still capped with sandstone and showing 100′ from pit mouth an upper bench 1′ 4″; slate parting 0′ 8″; coal 2′ 8″; slate 0′ 2″; coal 1′ 4″. In other words the bottom bench is still 4′ 2″ thick, but here carries an extra thin slate parting, and often showing 1″ of bony coal on top of this bench. Both the main and upper benches are unattractive, a sample of the lower bench, exclusive of the 2″ slate, yielding sulphur 1.514% and ash 12.455%. The bed is again opened up the stream at the Shannon, Peterman, Megary, Brady and Gilmore banks, without any improvement in character of coal or vital change in bed section.

Pine run branch of Crooked creek shows the Freeport coals coming out of water above Marion on the Indiana axis; the lower valley is destitute of coal. Bed E makes a distinct bench in Mr. Brady's fields, but its character is almost unknown in this region, where bed D is chiefly mined. On the Beatty farm 2½ miles east in the Blairsville basin this coal is 5′ thick; but around Marion it must be very much thinner not to have been opened.

At Kintersburg on Crooked run, under the arch of the Indiana axis, some uncertainty prevails regarding its identity, owing to the thinness developed in the Kinzua mine, where it is 2′ 6″ thick. But this may be only the rider coal; for where opened on Raynes branch on the Fry property it shows the rider (upper bench) 2′ 3″ to 2′ 6″; slate and clay 0′ 4″ to 0′ 7″; coal 0′ 8″ to 1′ 0″; slate 0′ 2″ and coal 1′ 6″ to 2′ 0″, averaging over all 6′ 3″.

To the north of Marion the Saltsburg axis is obliterated; but with the exception of territory around Richmond, the Little Mahoning valley is devoid of minable coal above water level in the Marion sub-basin. At Richmond the entire *Lower Productive group* is exposed by the Indiana axis; and the section is especially interesting from the occurrence of the *Ferriferous limestone*; the only place in Indiana Co. It is here quarried and is highly fossiliferous.

Bed E has been opened on the Sutton farm; also on the Richardson farm, in one bench, 3′ 2″ to 4′ 0″ thick.

On Plum creek at the village of Five Points in the *Saltsburg basin*, bed E is believed to show 3′ 6″ thick, although it is bedded horizontally like the *Upper Kittanning bed C′* and carries a 1″ slate parting beneath an upper 3′ coal bench. It is widely opened along this stream. On North Plum creek, below Plumville, at Wilson's mine near the Armstrong line, it shows 4′ 0″ thick in one good bench. On the Little Mahoning this coal is again lifted to daylight by the Perrysville axis at the mouth of Ross' run, but only for a short distance. It again shows 3′ 3″ thick, and its coal horizontally bedded, hard, compact and slightly pyritous. It has been opened by Messrs. Johnson, Pierce, Ruffner and Griffiths.

On Big Mahoning creek, in the north-west corner of the county, bed E is 200′ above the stream near the mouth of Little Mahoning, owing to the lift of the Fourth axis. At Good's mill the bed presents a clean breast of 4′ of coal, with columnar structure and hence somewhat tender; but it is a good coal and much more like bed E in the Allegheny Mt. region. From 6′ 0″ to 8′ 0″ of shale separated the coal from the overlying Mahoning sandstone and 15′ of of fire clay and fire clay shale from the underlying Freeport limestone, here 10′ thick.



separately and used for smithing purposes. It underlies bed E about 60′. It is not exposed on Crooked run, although above water level over the Indiana axis at Kintersburg; but it is the principal bed mined around Marion on Pine run branch, averaging about 3′ thick, but of an inferior quality, showing at Brady's mine sulphur 2.669% and ash 7.825%. Here the coal is 3′ 6″ thick, split in half by a thin but persistent slate band.

At Richmond, on the Little Mahoning, it is reported only 2′ thick, although it may not have been correctly identified here. In the Canoe valley it is evidently this bed that is opened in a number of places, locally known as the "*Schlemmer coal.*" Its development is mainly confined to Canoe township; to the west it is deeply buried in the Punxsuatawney basin of Jefferson and to the east it is largely eroded through the combined effect of the Indiana and Chestnut Ridge axes and the erosion of Little Mahoning creek and Bear run in the Blairsville basin.

The outcrop of bed D can be very plainly traced from Ugly run and the Pennsylvania and North Western R. R. south along Canoe creek nearly to the divide at Locust Lane, and then down the Little Mahoning branches to Richmond. It is also entirely cut out by Straight branch of Canoe creek and deeply indented by the Little Mahoning branches north of Robertsville. The coal bed however is everywhere inferior, both in bed section and chemical character to its condition in the western half of the Punxsuatawney basin as displayed along the Big Mahoning creek and branches in Jefferson county.

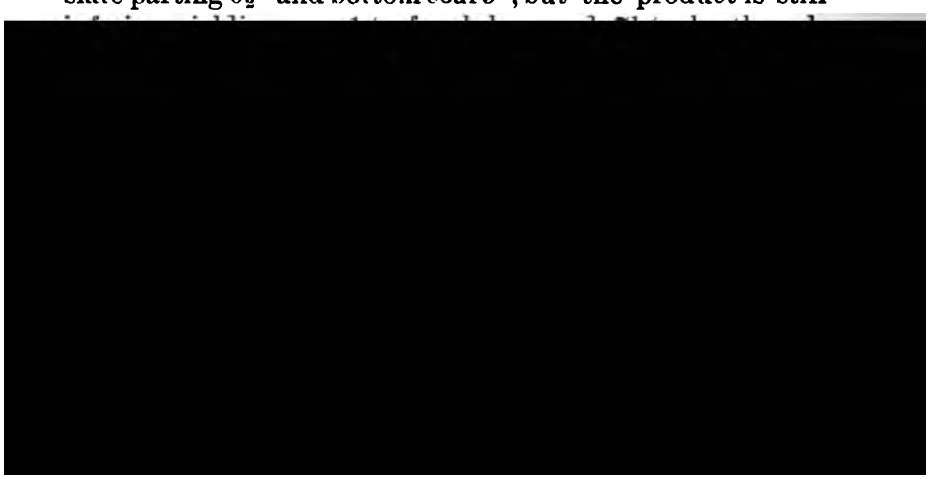
It is a significant but oft-repeated feature of Appalachian coal geology that the same coal bed, outcropping between the Susquehanna and the Big Mahoning through northern Indiana county should show such striking differences in bed section and purity within such comparatively short distances, such changes indeed occurring on either side of the Indiana axis itself, a purely imaginary line, as it merely marks a divergence of dip without making any break whatever in the coal field. Changes of a similar

character have already been noted in Somerset county on either side of the Viaduct axis.

The *Lower Freeport coal* is the only bed developed in the Canoe Creek region. The Piper bank on Hess run, just north of Richmond, shows an upper bench 2′ 1″ to 2′ 3″ and a lower bench 1′ 6″, pyritous, divided by a 1″ slate parting, with 3″ of inferior bony coal at the bottom of the bed, not mined. But the mining portion is impure, yielding sulphur 3.841% and ash 10.955%.

The Lewis bank on Broadhead run may average 4′ thick; but it generally carries 8″ to 9″ of bony coal on top, which cuts down the mining section to from 3′ 3″ to 3′ 6″. Openings have been made on Straight branch of Canoe, where the coal shows a better section, though rarely a first-class coal. At the Fairbanks (McGregor) mine the bed carries 3″ to 4″ of bone coal on top, and then about 4′ of coal below, the lower 5″ being rough slaty coal, quite different from the upper 3′ 7″ of bright columnar coal. An average analysis shows: sulphur .945% and ash 9.850%.

The Stiver bank, near Flora P. O., at the head of the run, shows fully 7″ of top bone; 3′ of coal, 1″ slate and 8½″ of bottom coal, the whole (exclusive of bone and slate) yielding sulphur 2.504% and ash 9.204%. The William Smith bank, lower down stream, has been very largely worked for local use. Here the top bench is only 3″; coal, main bench 3′ 3″; slate parting 0½″ and bottom coal 5″; but the product is still



blocks, is firm and dull, thus accounting for its large percentage of ash. Further examples might be given to illustrate the characteristics of this Canoe region; but the various sections and analyses sufficiently prove the inferiority of the Lower Freeport coal here as compared with southern Jefferson Co., the coal in no single instance showing a first class chemical character, though its area is large and bed section generally satisfactory.

*The Kittanning Group in the Marion-Saltsburg Basin.**

The *Upper Kittanning coal C'* is unknown in this basin south of Crooked run; but around Marion on Pine run it is exposed above the arch of the Indiana axis on the Hoffman farm, where it shows 2′ 6″ thick separated by 2′ 0″ of clay from the Johnstown cement 3′ 0″ thick. The coal is compact, horizontally bedded, and of different texture from the Lower Freeport bed D.

At Kintersburg on Crooked run the Middle Kittanning coal C is opened by Messrs. Walker and Carney 2′ 8″; but bed C′ is not explored. This bed also crops at Richmond on the Sutton farm; and bed C′ is opened on the Jeffries farm, as at Decker's Point, carrying 8″ of bony top coal; 5′ 3″ of main bench; 6″clay parting and 8″ of bottom coal, in all 7′ 1″. The coal is impure and mixed with iron pyrites, the main bench showing sulphur 3.162% and ash 5.350%. Bed B is believed to show on Leasure's property, to the west of the village, about 3′ thick. None of these beds seem to have any representative in the northern end of the basin in the valleys of the Little Mahoning, Canoe and Straight creeks.

No. XIII in Armstrong County.†

Armstrong Co., being situated midway between the Oil regions of Clarion and Butler and the Pittsburg Coal region of Westmoreland, relies for its mineral prosperity on

*For sections see plate 448.

†Report H 5. W. G. Platt, 1880.

the coal beds of the *Lower Productive Series* which outcrop along its valleys; on the extensive outcrop of the *Ferriferous limestone** through its northern townships, (which sometimes becomes a very thick bed,) and the overlying *Buhrstone iron ore*; and on some local outcrops of valuable fire and pot clays. Building and flagstone outcrops are only too numerous for the agricultural interest of the district; the confinement of railroad facilities largely to the Allegheny river and Red Bank creek valleys has naturally somewhat retarded the active development of its economical resources. The complicated structure† of the county is illustrated in plate 449.

*The variations of character and thickness exhibited by the *Ferriferous limestone* of the coal measures in Armstrong Co., are as striking as they are in the counties to the west. This curious deposit has been laid down in some parts of the district and not in others, and it varies from nothing up to 27'; is sometimes solid, sometimes sub-divided into layers separated by shales; in some places is richly fossiliferous, and elsewhere exhibits scarcely a trace of animal forms. At Bagdad and at Townsend's station for instance, it cannot be found, but reappears at the Leechburg tunnel; around Leechburg it goes and comes and is non-fossiliferous; it hardly appears anywhere on the Roaring run, but is seen on Rattling fork; is variable at Apollo, and for four miles on a stretch is replaced by shales. In Indiana Co. it was deposited only in the western half of the county and can not be found anywhere to the eastward. On the other hand it becomes persistent, thick, pure, and highly fossiliferous towards the west, in the Allegheny River valley and in the valleys of Buffalo creek, and continues as a great geological formation, the key to the geology, and the guide of the oil-well sinker, throughout Butler, Beaver and Lawrence Cos. into Ohio, everywhere carrying more or less of the *Buhrstone carbonate* and *limonite iron*

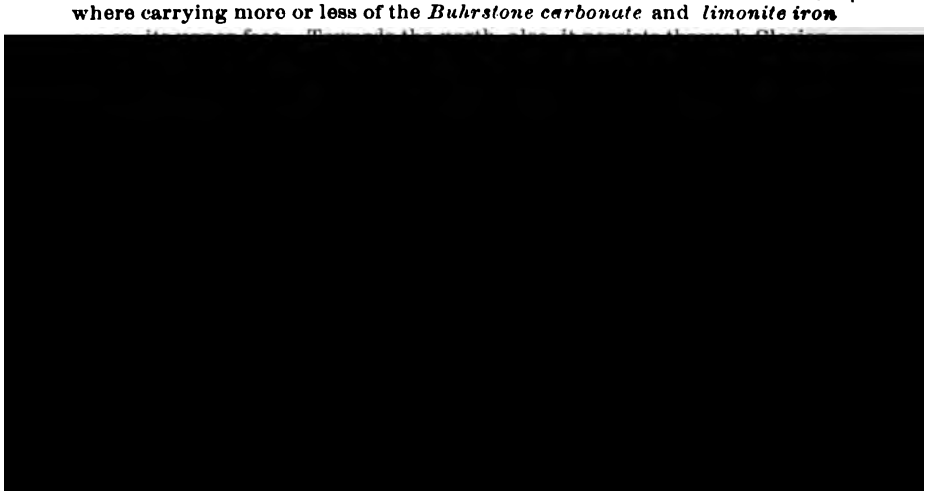
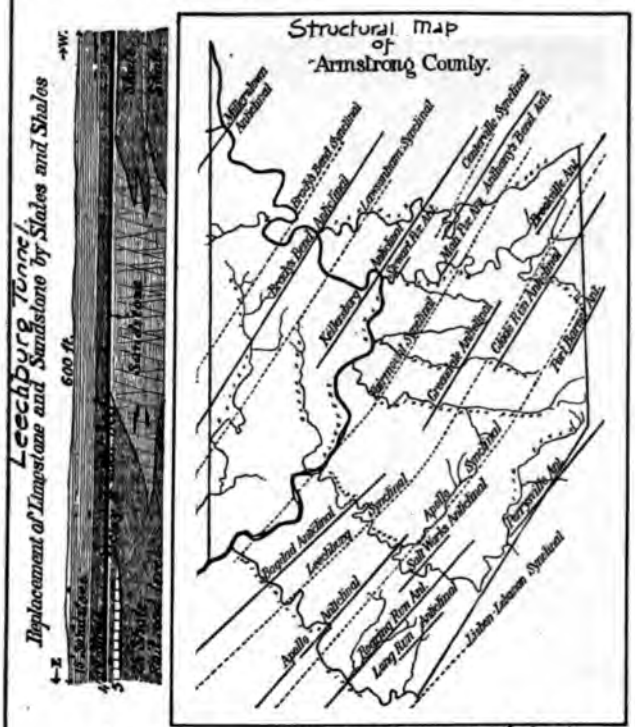
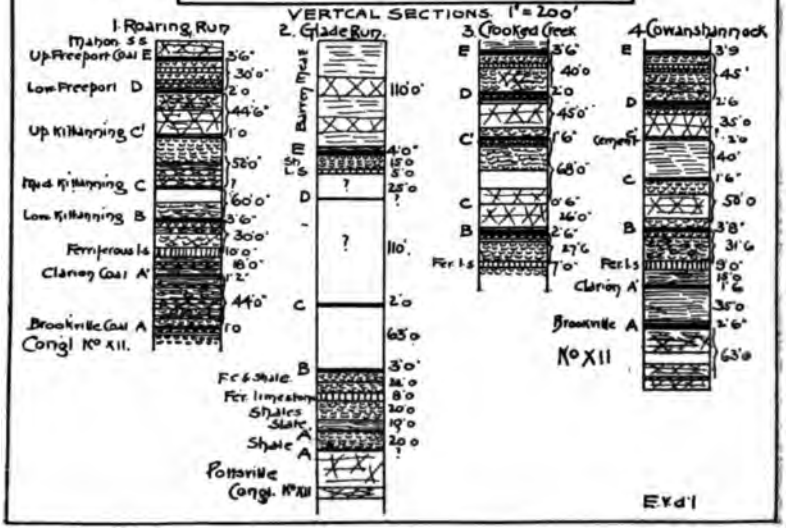


PLATE 449

No XIII Allegheny River Coal Series in Armstrong Co.



VERTCAL SECTIONS. 1" = 200'





The *Carboniferous system* occupies the whole surface of the county, with a maximum exposed thickness of 1400′. The *Lower Productive Measures*, where fully developed, constitute a group 300′ thick. Shales interchange with sandstone beds, and coal seams expand and diminish in thickness over short areas; but great uniformity prevails in the aggregate thickness of the group throughout the county.*

They occupy the valley of the Kiskiminitas from Salina down; but the entire group is only brought to daylight once—at the mouth of Roaring run by the Roaring Run-Murraysville axis,—where its character is shown in section plate 449 fig 1. Of the Kiskiminitas section the only coal beds of value in a mining sense are the *Freeport upper* and the *Kittanning lower*, about 180′ apart; and though rarely more than 4′ thick and frequently less, they are at least uniform and persistent. The *Ferriferous limestone* 10′ thick, is a conspicuous feature of the section, this being its first appearance along the Conemaugh west of the Allegheny Mts. It is only exposed on the flanks of the Roaring Run axis and practically marks the outcrop of the overlying *Kittanning lower coal bed B.* Below Apollo† the *Freeport upper coal E* is the principal source of a fuel supply for this valley. It is available for mining on both sides of the river from Salina to the Allegheny; all along that river in Clarion Co.; in the deep valley of Crooked creek and along the countless small tributaries of these main streams. The Freeport upper coal at Salina varies from 3′ to 6′, with an average of about 4′ in thickness. Small but persistent slate partings traverse the seam and materially affect its commercial value. (See sections plate 451

Armstrong is true of every other county in the Bituminous Coal Field of Western Pennsylvania. The uniform simplicity of structure formerly ascribed to it is lost to view, and it takes its regular place now with other complicated regions of the earth's surface.

*See plate of sections in this report 449 and 450.

†At Apollo the *Gallitzin coal* of No. XIV attains workable size, occurring 55′ above bed E, with the Mahoning sandstone between. It yields a compact pyritous coal 2½′ to 3′ thick.

figs. 1 to 16). It also carries fully 1% of sulphur. The limestone beneath it is fully 10′ thick, in one layer, smooth dove colored stone of good quality.

The Freeport fire clay is also of importance and value at Salina; apparently fading away westward, down the river. It has been largely used in the manufacture of fire brick, and is hard and brittle with an irregular fracture and dark pearl gray color.

The Freeport upper coal is frequently exposed too, and indeed is plainly visible everywhere from Roaring run to Leechburg. At its best it shows around Apollo an upper bench 2′ 4″ to 3′ 0″; slate parting 1″ to 2″; lower bench, often slaty 1′ 0″; total 4′ 2″. The coal is usually compact and firm, bearing shipment well; but carries over 2% of sulphur. Its limestone bed is variable. As stripped for the Soda Works it shows 15′ to 20′ thick in several layers divided by bands of shale, becoming argillaceous when traced westward and finally converted into shale entirely, so continuing past Apollo station and Townsend's to Leechburg.

At the McIntyre mine the coal is 3′ 0″; continuing regular and even with about same thickness to Leechburg, where it has been extensively mined on the Westmoreland side 3′ 9″ thick, and yields a good coal for steam and mill purposes and a block coal used for locomotives. The limestone occurs in two benches 2′ 6″ and 3′ 6″ thick, divided by 5′ of clay with ore balls. In the tunnel at Leechburg there is an interesting exposition of the entire replace-

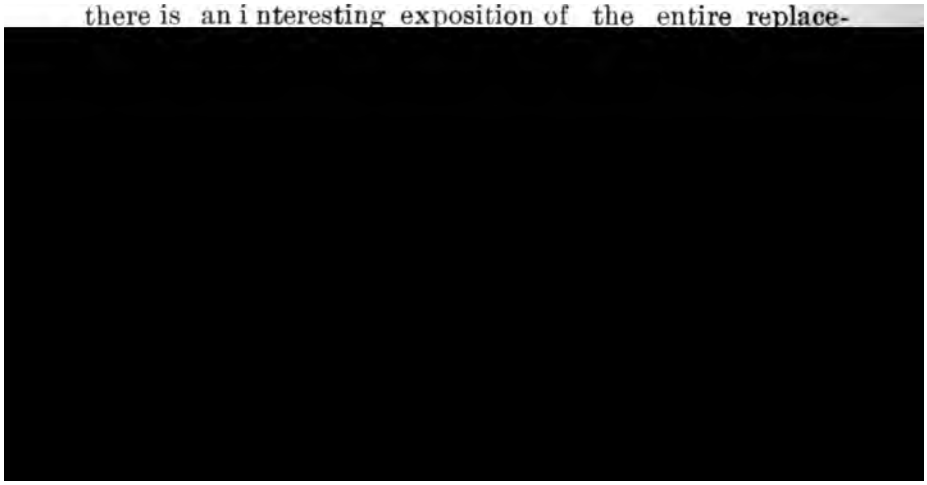
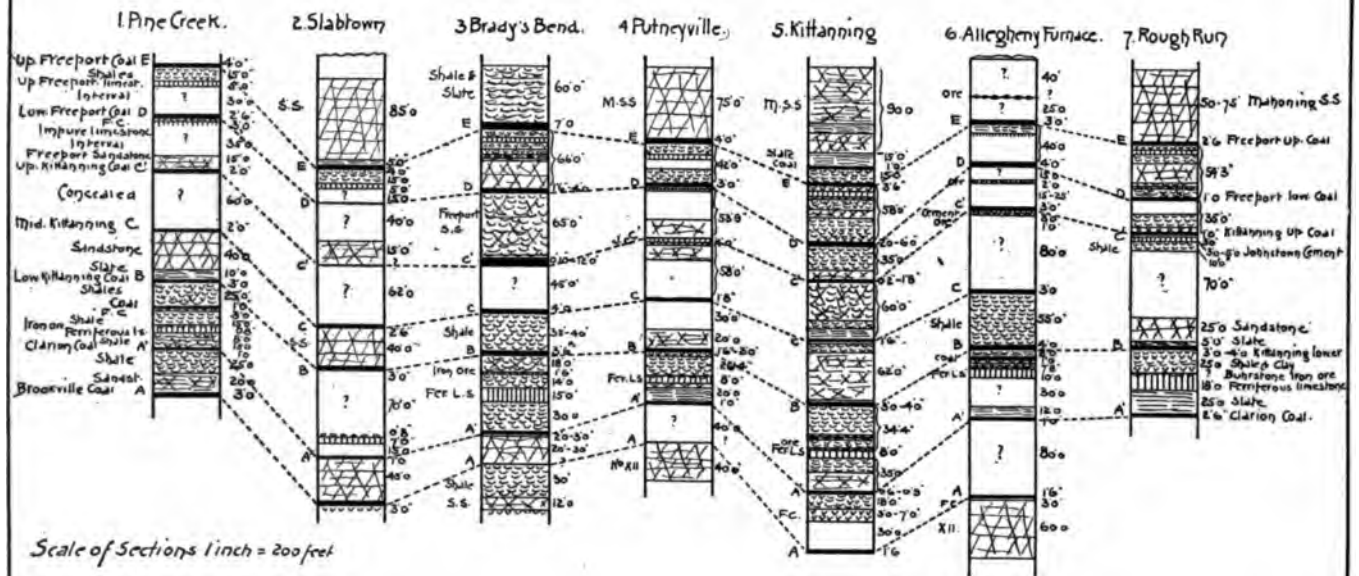


PLATE 450

No XIII Allegheny River or Lower Productive Coal Measures in Armstrong County, Penn.ª



Ev. d. l.



thick is separated from the lower coal bench by 10′ of fire clay shale. In Roaring Run valley the coal carries a thickness of about 4′ with great regularity, opened in many places, carrying a small 1″ slate parting, 3′ 7″ on top and and 10″ of coal below at the Helty mine.

Along Crooked creek the *Lower Productive Measures* are exposed from the Indiana line to the Allegheny river owing to the presence of a large number of low anticlinals and synclinals. The *Barren Measures* overspread all the highlands along both sides of the creek.

The *Freeport upper coal* is the only reliable bed on this stream; the *Kittanning group* contains little of practical interest and is exposed in its entirety only along the crown of the Roaring Run axis. Bed E averages about 3½′, never especially pure or free from slate and frequently showing the presence of iron pyrites. In all respects of structure, interval and character the entire group here strongly resembles the Kiskiminetas section. At the Barr mine it is 3′ 2½″ thick with a 0½″ slate parting about 6″ above the floor; slaty and pyritous. The *Lower Freeport* is rarely over 2′ thick, lying from 40′ to 50′ beneath bed E.

Along Carnahan run, coal E is slaty and thin. Near the Union church, further west it becomes better and shows at Hellman's 3′ 9″ thick, with 3″ of slate and 5″ of top bony coal. On Plum creek, at the Anderson property, the bed carries from 8″ to 1′ of slate and bony coal, separating a top bench of coal 1′ 8″ thick from a bottom bench of slaty pyritous coal 2′ to 3′ 10″. On the South Fork of Plum creek the coal has been opened at many places 3′ 4″ thick. The coal is hard and compact, with small knife-edges of slate and some pyrites, but of fairly good quality. On Dutch run branch it shows two benches, the upper 2½′ and the lower 6″, with a thin slate parting between. Coal is hard and compact. On the main Plum creek the bed varies between 3′ and 4′, but of not an especially good quality. The Freeport limestone shows in two bands, 1′ 6″ and 2′ 6″, separated by 1′ 6″ of clay shales. In Cherry Run valley the coal

shows about 3′ 6″ thick on an average, generally divided by one small parting.

On the Cowanshannock the *Lower Productive group* twice appears in full above water level; once at Patterson's mine over the Greendale axis line and again below Nutton's tavern, at both places showing a parallel section to Crooked creek. (Plate 449, figure 4).

The *Clarion group* (beds A and A′) is unimportant; but both the *Kittanning lower* (B) and *Freeport upper* (E) are uniform and regular and can be profitably mined. Both are sparingly developed and show rather inferior coal. The limestone beds of the series are everywhere well developed. Bed E improves going south along this creek, and is especially good in the region of the North Star mines, where at Baer's mine it shows 4′ 4″ thick, with 1″ of slate; 3′ 3″ top coal and 1′ 0″ of bottom coal. At Patterson's mills it varies from 2½′ to 4′ thick; at Robinson's, further down the creek, 3′ thick, but poor and slaty.

Along Penn creek, the *Freeport upper coal* is again the important seam, being thicker and showing better coking qualities than the others. Around Dayton it is impure with all the other coal seams; but in Bogg township and around Pine Creek furnace its superiority has been demonstrated at many openings. On opposite sides of the Glade Run axis it shows 4′ 1″ thick, carrying a 1″ slate parting 4″ above floor. West of Dayton the bed is uniformly 4′ thick



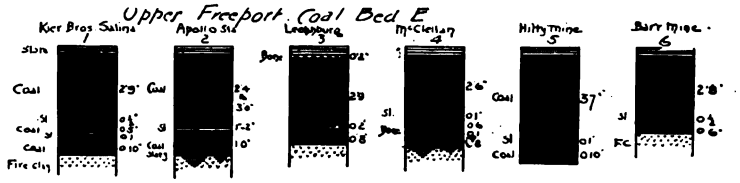
Plate 451.

No XIII. Allegheny Series in Armstrong Co. Penna

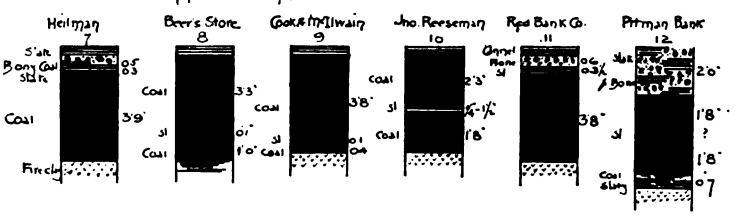
Coal-bed Sections from Report H^5

Scale 1" = 8'.

Upper Freeport Coal Bed E

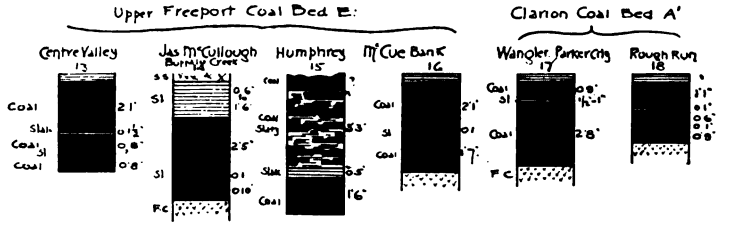


Upper Freeport Coal Bed E.



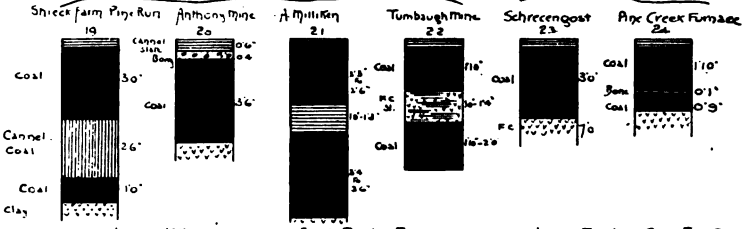
Upper Freeport Coal Bed E.

Clarion Coal Bed A'



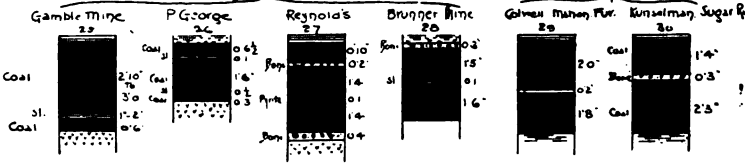
Upper Kittanning Coal Bed C'.

Lower Freeport Coal Bed D



Lower Kittanning Coal Bed B

Lower Freeport Coal Bed D



Scale 1" = 8'



hill tops. In the Red Bank Co.'s mine it shows 4′ 5½″, the top 6″ being bony, then 3½″ slate and 3′ 8″ of bottom coal; but the bed is somewhat squeezed by rock faults and horsebacks, and carries over 1½% of sulphur and 6½% of ash.

Along the main Allegheny River valley the entire *Lower Productive group* is exposed, with a covering of *Barren Measures* and a prominent outcrop of the Ferriferous limestone extending down the river to Kittanning and Williamsburg. Along the Butler county line the *Upper Freeport coal* shows at Pitman's 5′ 11″ thick; but its section has 2′ 0″ of top bone coal and slate; 3′ 4″ coal divided at center by a thin slate and 7″ of hard and slaty bottom coal.

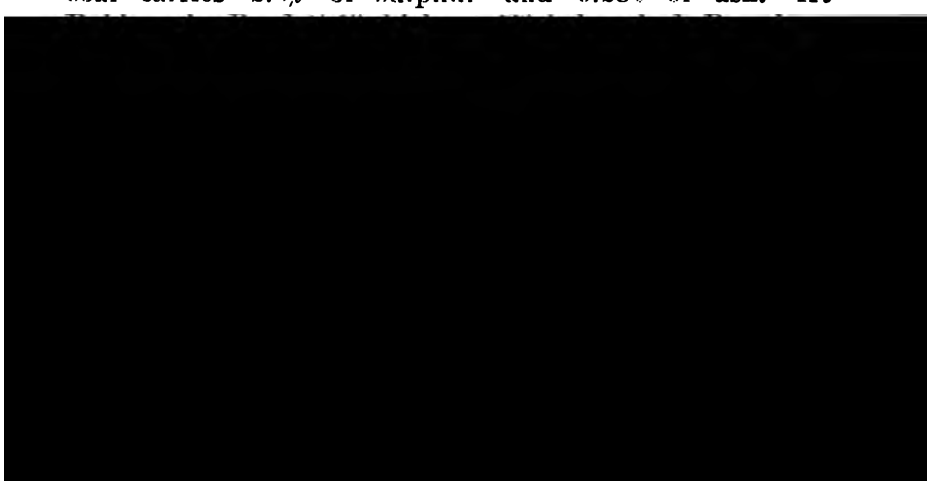
At Brady's Bend, coal E, locally known as the "*Summit Vein*" is described as having four benches: top 1′ 0″; second bench 2′ 4″; slate 0′ 3″; third bench 1′ 10″; slate 6″ to 2′ 0″ and fourth bench 0′ 4″. It is a bright rich coal, with streaks of pyrites, but only the second and third benches are mined out. Around the old Ore Hill furnace this bed is about 3½′ thick, but in excellent condition and quite pure. With about this thickness it was worked at the Allegheny furnace; used for coking by the Monticello furnace; and worked at many points between the river and Cowanshannock creek; Troy hill and Kittanning. But its condition is not so favorable at the latter place, (though its section often reaches 4′) as the Lower Kittanning coal bed B.

At Manorville the *Freeport upper limestone* becomes quite prominent, increasing in thickness south from Kittanning to 28′ at Manorville, thence decreasing to Freeport. It has been largely quarried for furnace use, being high in lime and low in phosphorus. The overlying bed E is about 3½′ thick, and the same at Center Valley above Kelley's station where it shows top coal 2′ 1″; slate 0′ 1½″; coal 0′ 8″; slate thin; coal 0′ 8″. At Freeport it holds the same thickness (3′ 6″); but the Mahoning sandstone is decidedly the most conspicuous geological feature of this district, massive and finely developed. The coal is impure.

In the valleys of Glade, Limestone and Buffalo creeks, west of the river, the *Freeport upper coal* shows 4′ to 5′ thick in the Reed settlement; but this increased section is gained at the expense of purity. It is a double bed, showing at Humphrey's top coal, slaty 3′ 3″; slate parting 0′ 5″; bottom coal 1′ 6″; total 5′ 2″. Southward the parting diminishes and the bed improves in quality. The bed is irregular in the Buffalo Creek region. At McCue's 3′ 9″ thick, with a 1″ slate parting. It is of uncertain value and generally absent over all the region east from Foster's Mills toward Middlesex: in the hills north of the West Branch; north and south from Worthington.

The *Freeport lower coal bed D* attains commercial size and importance at but few places in the county. On the Kiskiminetas it ranges about 2′ thick; of no value at all at Leechburg and Bagdad and assumes a cannel structure at the mouth of the river. On Crooked creek only 2′ thick at Barr's; hardly discernable at Cochran's Mills: in Carnahan's ravine 2′ 6″ underlaid by limestone, but impure, swelled locally at the bridge below Methodist Church to 4′ 6″ with partings. It is poorly exposed along Plum creek and does not appear to be over 2′ thick.

Near Rural village on the Cowanshannock it is mined 50′ beneath bed E and shows 3′ 0″ thick, underlaid by 7′ of impure fire clay and 2′ of ferruginous limestone: but the coal carries 2.3% of sulphur and 9.28% of ash. At



0′ 3″ bony cool separating an upper bench 1′ 4″ and a lower bench 2′ 3″ thick. At Bostonia mines the seam is so overloaded with iron pyrites as to be worthless; but on the opposite side of the creek at Fairmount, it shows in superb condition, from 6′ to 7′ thick against 4′ at Bostonia, where it is also much troubled and irregular and carries 3.38% of sulphur.

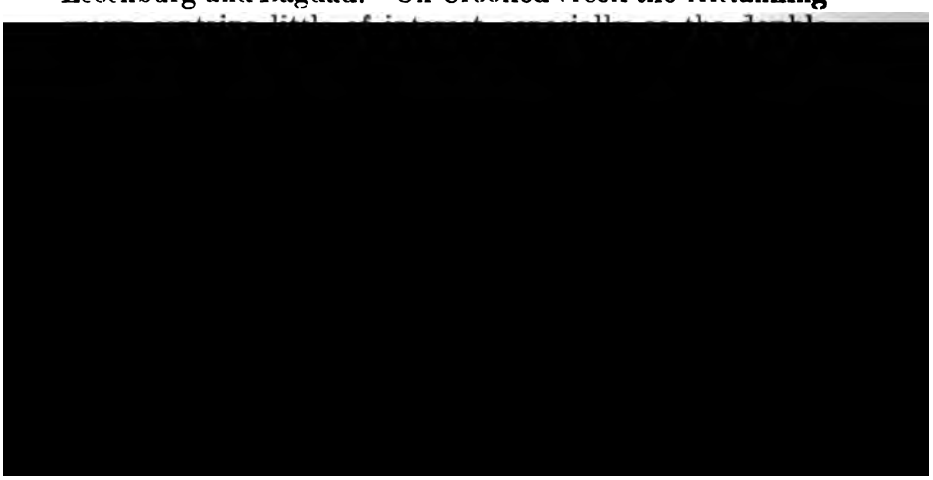
It crops in all the summits west of Oakland, but not worked. It is very variable at Brady's Bend on the Allegheny river, but becomes of importance along the right bank of the river at Allegheny furnace, where it measures 4′ thick. Towards the north and east it thins away rapidly, becoming obscure in the Pine Creek region and at the mouth of the Cowanshannock. Further down the river towards Kittanning it is called the "*Rolling vein*" from its great variation. On the Buffington property it varied from 8′ or 10′ down to nothing. North-east of Kittanning at one point it shows 13′ 5″ thick with a double upper bench (coal 3′ 0″; slate 0′ 3″; coal 0′ 6″); a main shale parting 6′ 0″ thick and a bottom bench 3′ 8″ thick, the latter clean.

At Manorville it is also a double bed 4′ thick, with a parting shale 1″ thick, and here only 35′ below the Freeport upper coal. At Kelley's station the bed shows a semi-cannel structure and keeps that character to Freeport; but the coal is slaty even for domestic use. West of the river in the Worthington region, it is only 2′ thick at its best, and extremely irregular in the Reed settlement, sometimes 6′ without slate partings; elsewhere contracting to less than half that section, and always pyritous and dirty. South from Worthington, in the hills overlooking Buffalo creek it averages 3½′ thick and occasionally expands to 4′ without persistent partings. The bed is worthless along the lower waters of Buffalo creek.

*The Kittanning Group: Beds C', C and B.**

Along the Kiskiminetas river the exposed area of the lowest (Lower Kittanning) coal bed of this triple group is comparatively small, being confined to the arch of the Roaring Run axis; but while the *Middle* and *Upper Kittanning seams* have a greater outspread, they are generally thin. The *Buhrstone iron ore*, is not reported along this stream; but the valley is bountifully supplied with limestone from the Ferriferous and Upper Freeport lime beds, as well as with fire clay deposits to some extent. In the vicinity of Northwest the two upper beds are both concealed; but bed B was mined at the Gamble salt works, yielding about 3½′ of strong coal, here preferred to bed E. Still it is both pyritous and shaly and its section shows top bench 2′ 10″ to 3′ 0″; slate 0′ 1″ to 0′ 2″; bottom bench 0′ 6″. This section is duplicated at the old Rough furnace up the run (See Plate 451.).

The *Ferriferous limestone* occurs 30′ beneath this coal and is 10′ thick. The Lower Kittanning coal is again opened at the mouth of Roaring run 3½′ thick, and lower down the river at McLaughlin's, pyritous, compact and firm as at Gamble's, but parted near the top by slate. The Appollo axis only lifts the upper part of the *Kittanning group* to daylight, showing the Kittanning upper coal C′ only 1′ thick near water level. But the seam is scarcely exposed at Leechburg and Bagdad. On Crooked creek the Kittanning



pure; but below it there is a mass of potter's clay in great abundance which has been mined and used by Messrs. Knees and Sons. The *Ferriferous limestone* is well developed where exposed, 243′ below the Freeport upper coal. At the "Loop" down the creek the sandstone beneath bed B is conspicuous, and the coal above it about 3′ thick. At Cochran's Mills the Upper Kittanning coal is 2′ underlaid by fire clay 2′ and the Johnstown cement bed 3′ 0″ thick. The cement stratum is fossiliferous. On Carnahan's run the coal is 3′ thick but partakes of cannel structure. At the mouth of Cherry run it is so accessible that it has been worked for local use; but though running up to 3′ it averages only 2′ thick.

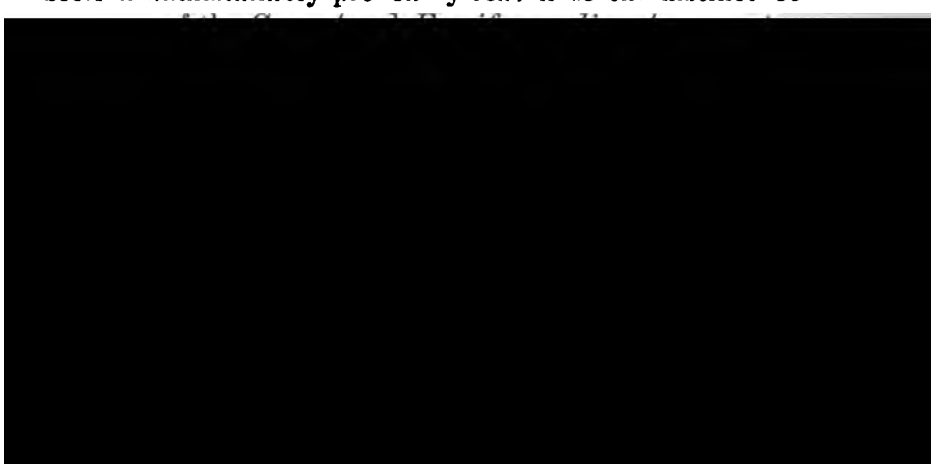
On the Cowanshannock the Lower Kittanning coal, though still impure, is regular and uniform. At Greendale P. O. (Patterson's Mills) it is opened on the Rhea property, sometimes roofed by sandstone, irregular, and sometimes by shale or slate, the coal in consequence varying from 2½′ to 4′ in thickness, while only 16″ thick at Caldwell's tavern. At Rhea's the Ferriferous limestone lies fully 60′ below this coal; but only 25′ at Caldwell's. It has an outcrop area over the Greendale axis, 8 miles long and from 8′ to 10′ thick. Along the lower waters of this creek the Kittanning lower coal B is overlaid by a conspicuous sandstone 35′ thick, with bed C above it 18″ thick and bed B below it 4′ thick at Patrick's mine, compact and bright coal, but pyritous. On Pine creek waters only the lowest of the three Kittanning beds can be depended upon with reasonable certainty to maintain a condition of workable thickness. It has a considerable outcrop area on both forks, but generally impure.

The *Ferriferous limestone* however becomes a most regular and persistent stratum through both valleys. It makes excellent furnace flux and is no less good in the kiln; splits easily in quarrying and is favorably located for attack. The *Buhrstone* (carbonate) *iron ore* is an unfailing attendant of the limestone. Over the Glade Run axis the Lower Kittanning coal is lifted 50′ above the South

Fork at Wadding's, and is reported 3′ thick. Between Echo and Belknap all three coals are exposed: the *Upper Kittanning* 2′ 10″ thick and good coal; the *Middle Kittanning* on the George Rupp farm, much parted and slaty, 2½″ thick and abnormally 6′ 0″ thick at Kline's, where it carries a rider, making the top bench 3′ 5″ thick, slaty and bony coal; parting 1′ 0″ and lower bench 1′ 7″; and the *Lower Kittanning*, largely unexplored, about 2′ thick, increasing westward to 3′ at Echo.

At Pine Creek furnace the Ferriferous limestone was quarried 8′ to 10′ thick, 40′ beneath bed B, here impure and 2½′ thick. Along the north fork of Pine creek the group shows a similar character. The Mahoning Creek section shows bed B quite regular, but less pure and reliable than the Upper Freeport bed E. The Upper Kittanning coal is locally important, furnishing an impure cannel and cannel slate along Mud Lick and at New Bethlehem on the Red Bank. Around Milton bed B lies 40′ above the Ferriferous limestone horizon (here mainly iron ore) and is about 3′ thick, which is also its character in the valley of Glade run, and down the creek below the McCrea furnace.

At Putneyville a most satisfactory section of the whole *Lower Productive group* is obtained, and it was through this exposure that the nomenclature of the series was firmly established and its identity with the Allegheny Mountain section unmistakably proven by reason of the distinct oc-



wise an important stratum. At the Stewardson furnace it was use as flux and 9′ thick in one compact bench; but the Kittanning coals are thin and poor.

The *Kittanning upper coal C′* has gained considerable notoriety in the valley of Mud creek and at Bostonia on Red Bank, where it occurs as an impure cannel coal, once largely mined. It here lies exactly 100′ below the Upper Freeport coal E. Its outcrop as cannel is extremely irregular and uncertain, the deposit being quite local and intermittent, and its areas detached. Usually where the cannel occurs it is wedged between two layers of bituminous coal, the deposit consisting of "a series of lenticular masses which feather in an east and west direction towards the edges, and deepen downwards. The floor, therefore, is undulating while the roof and upper layer of bituminous coal are a more or less regular plane. In this manner a succession of miniature troughs is formed with slightly elevated ridges between. At the centers of these troughs the cannel is thickest and the layers of bituminous coal widest asunder, whereas on the backs of the dividing ridges the layers of bituminous coal unite and the cannel is pinched out." The bed is strictly everywhere a cannel slate with a conchoidal fracture. It is exposed at its best along Mud Lick, but hardly commercial there.

Along Pine run, above Charleston, bed B is 3′ thick. Above New Salem it is only 2′ 7″ and impure, and it is the only bed of minable thickness around New Freedom. Bed C is neglected and probably of no value; but bed C′ on the Schieck farm again shows its cannel feature, carrying a top bench of soft bituminous coal 3′ 0″ thick; then 2′ 6″ of cannel and finally 1′ 0″ of soft bituminous coal.

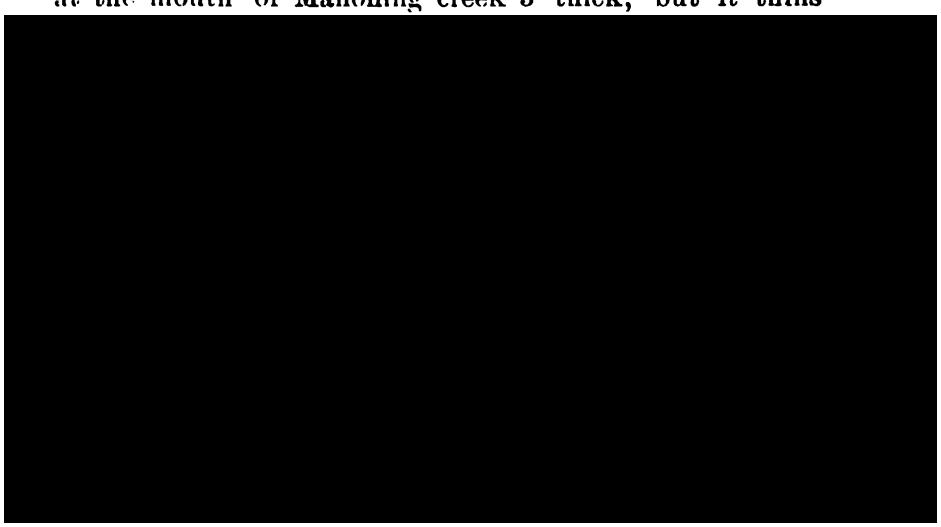
The *Kittanning lower coal* is 3′ thick around New Freedom and in the valley of Mud Lick and 2½′ thick at New Bethlehem. The Kittanning upper is largely black slate at these places, but becomes the principal bed west of Oakland, showing at the Anthony mine, cannel slate on top 6″, soft slate and bony coal 4″, coal on bottom 3′ 6″, total 4′ 4″. At Kellersburg bed B is 3′ thick and ranges

through the hills southward to the river and the Mahoning creek.

In the main Allegheny River valley the *Kittanning group* is variable. Above Parker City bed B is small and of no value; but on the Evans and Snow properties at Monterey it shows 4′ thick, including 6″ of top bony coal and a slate parting near centre. At Brady's Bend the Kittanning upper coal C′ is 10″ thick along the river point, but receives a rider of cannel slate on Holder's run and swells to 12′ in thickness, but then of no commercial value.

The Kittanning lower, "*Furnace Bed*," was formerly mined for the rolling mill, but is much affected by local swamps and rolls. In the Sugar valley it is largely mined also for local use, though sulphurous and slaty. Along Greenville run it shows an increased section. The Buhrstone ore bed is 2′ thick; and the Ferriferous limestone bed 15′ thick.

Between Brady's Bed and Red Bank creek at McKee's the Lower Kittanning bed is 4′ thick and in the vicinity of Rimerton at the mouth of Red Bank creek, bed B is regular and persistent; but impure, about 4′ thick and carrying 6″ of bony coal on top. The Mahoning Coal Co. mined it at the mouth of Mahoning creek 3′ thick; but it thins



to the Brookville coal (Plate 450 fig. 5). The Lower Kittanning coal is the "*Town Vein*" here. It is commercially inferior to both the Freeport coals but more accessible. It is much parted and pyritiferous. At Thompson's it is barely over 3′, so badly parted as to yield only 2½′ of coal; and at Reynold's quarries, though 4′ 1″ thick, it yields an indifferent slaty coal, overloaded with pyrites, with two bone partings of 0′ 2″ and 0′ 4″ and a pyritiferous slate parting of 0′ 1″ separating three coal benches. The Middle Kittanning coal lies 60′ higher but is not workable; so too the Upper Kittanning. Above Logansport bed B is 3′ 3″ thick; but it yields little good coal, carrying 3″ of bony coal on top and a 1″ slate parting in centre.

In the territory west from the river and south of Brady's Bend the Kittanning upper coal is the main seam in the Middlesex region, showing at Crawford's, Campbell's and Conan's 4′ thick, with small and irregular slate partings. Traced southward the bed is split by a persistent layer of slate, first thin but gradually increasing to damaging proportions, until at Milliken's it shows top coal 2′ 3″ to 2′ 6″; slate parting 1′ 0″ to 1′ 3″; bottom coal 3′ 4″ to 3′ 6″. It is also a prominent bed in the Reed settlement; and while all the seams are thick here, they manifest a local abnormal growth which does not maintain itself in any direction. Thus in the Centre Hill ravine bed C′ is only 20″ thick, whilst bed B at Weants, Fair's and Montgomeryville is 3½′ thick, yielding a good hard dry fuel. At Foster's Mills in Sugar Creek twp., the latter bed is also 3½′ thick, slaty and impure, but much more extensively developed at Buffalo Mills, where it holds the same thickness and is opened in a great number of places. Bed C′ appears at several localities, and in the Tumbaugh mine on Long run shows 5′ 2″ thick, but divided by 1′ 0″ to 1′ 4″ of slate near center.

Clarion Series: Beds A and A′.

The *Brookville coal A*, resting on top of the Conglomerate on the Kiskiminetas over the Roaring Run arch, is small and unimportant. The coals of this group are rarely

exposed above water level on Crooked creek, Pine creek and various small tributaries and are both of inferior thickness and significance on the Cowanshannock. They are of little or no value on Pine creek waters, the *Brookville A* being above water level over only a limited area and the *Clarion A'* always too small for profitable mining. On the north fork in the vicinity of Slabtown and Brookville bed becomes locally workable and 3′ 2″ thick, parted by 1″ of slate; but bony and impure. On the Mahoning waters both coals are thin and worthless and they are little better on Red Bank though locally mined in the absence of other less accessible beds. Bed A is 18″ to 20″ thick at Maysville and the Clarion A′ is 2½′ thick around Fairmount.

In the Allegheny River valley all the coal consumed in the engines and that used for domestic purposes around Parker City was derived partly from the Clarion and partly from its split, the *Scrubgrass coal bed*, but mainly from the former, which is here thicker and better than elsewhere in Armstrong Co., though still an impure pyritous coal. Its average thickness shows a top coal of 0′ 9″; a parting slate about 0′ 1″ and bottom coal 2′ 8″; total 3′ 6″. The coal is hard and compact and is mined out in blocks. The *Scrubgrass bed*, occurring just midway between the Clarion coal and Ferriferous limestone is 2½′ to 3½′ thick, the latter in the Anchor ravine, where it shows top coal 2′ 3″; slate 0′ 3″; coal 1′ 0″; total 3′ 6″. It is here apparently less slaty and pyritous than the Clarion seam.

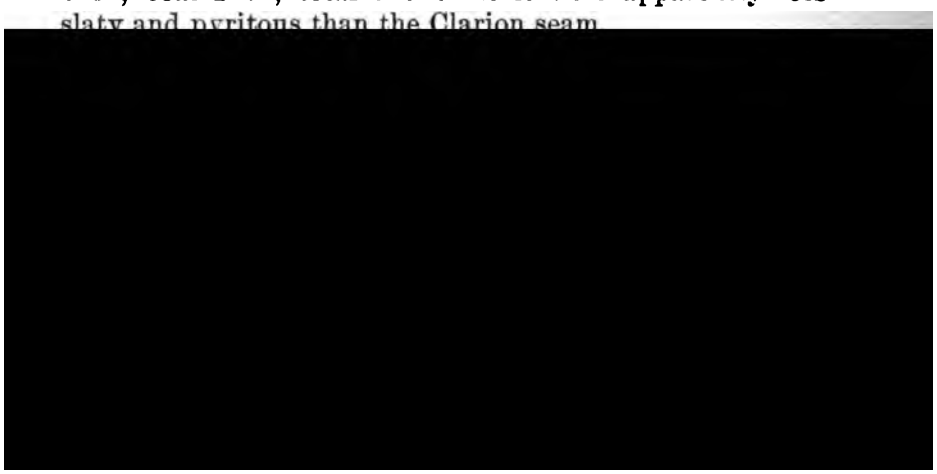


Table No. 1.—Analyses of Coals in Armstrong County.

	Name of Coal Bed. *Allegheny Series.*	Owner.	Locality.	Water.	Volatile matter.	Fixed carbon.	Sulphur.	Ash.	Fuel Ratio.
E.	Freeport Upper Coal bed,	Kier Bros., . . .	Salina, ...	1.060	33.955	54.392	1.058	9.535	1:1.60
	" " " . .	Laufman & Co., .	Apollo, ...	1.410	38.560	52.249	2.381	5.400	1:1.35
	" " " . .	Beer Bros., . . .	North Star, ...	1.140	37.860	57.179	1.031	2.790	1:1.51
	" " " . .	T. H. Marshall, .	Dayton, ...	1.040	32.330	49.450	2.000	15.180	1:1.53
	" " " . .	Jno. A. Colwell, .	Mahoning Furnace,	1.450	34.810	54.996	1.054	7.690	1:1.58
	" " " . .	Laughlin, ...	Stewardson Furnace	1.470	35.520	55.545	.835	6.630	1:1.56
	" " " . .	Red Bank M. Co.,	Bostonia, ...	1.840	35.940	53.661	1.739	6.820	1:1.49
	" " " . .	Jno. Hagy, . . .	Freeport, ...	1.430	39.835	50.206	2.819	5.710	1:1.26
D.	Freeport Lower Coal bed,	Schreckengost, .	Rural Village, . . .	.910	34 270	53.224	2.311	9.285	1:1.55
	" " " . .	Brown&Mosgrove	Pine Creek Furnace,	1.820	34.185	58.301	.989	4.705	1:1.70
	" " " . .	John A. Colwell,	Mahoning Furnace,	1.070	37.110	50.265	3.225	8.330	1:1.35
	" " " . .	Red Bank M. Co.,	Bostonia, ...	1.690	35.940	53 950	3.380	5.040	1:1.50
	" " " . .	Reed, ...	Centre Hill, ...	1.010	40.210	47.366	3.824	7.590	1:1.18
C'.	Kittanning Upper Coal bed,	Thompson's, . .	New Salem, ...	1.220	37.930	52.757	1.388	6.705	1:1.39
	" " (cannel),	" . .	"	1.610	37.830	53.132	.678	6.750	1:1.40
	" " " . .	" . .	"	.810	34.465	54.482	.588	9.655	1:1.58
	" " " . .	Brooks, ...	Cathcart run, . . .	.640	32.665	52.306	1.044	13.345	1:1.60
	" " " . .	Red Bank M. Co.,	Bostonia, ...	.510	30.490	46.194	.576	22.230	1:1.51
	" " " . .	" "	"	.730	31.680	49.815	.455	17.320	1:1.54
B.	Kittanning Lower Coal bed,	Mahoning Coal Co.	Mouth of Mahoning,	1.180	42.550	49.686	1.999	4.585	1:1.17
	" " "	Ross Reynolds, .	Kittanning, ...	.950	40.855	51.694	1.366	5.135	1:1.26
	" " "	Rodgers, ...	Butler Co. line, . .	1.160	42.720	48.742	2.313	5.065	1:1.14
A'.	Clarion Coal bed, ...	Fox, ...	Parker City, ...	1.310	45.025	46.916	2.954	3.795	1:1.04
	" "	Winfield Furnace,	Rough Run, ...	1.010	42.650	48.661	1.644	6.035	1:1.14
A.	Brookville Coal bed, , . . .	Jno. Mortimer, .	Slabtown, ...	.740	35.715	51.049	.936	11.560	1:1.43

Table No. 2.—Analyses of Limestones.

Owner.	Locality.	Carbonate of Lime.	Carbonate of Magnesia.	Oxide Iron & Alumina.	Phosphorus.	Insoluble residue.
John Reefer,	North Star,	88.839	1.513	2.557	.021	5.030
Wm. Marshall,	Dayton,	94.928	1.210	1.246	.018	1.920
Wm. Hamilton,	Putneyville,	84.857	1.868	2.568	.024	9.520
A. J. Dull & Co.,	Manorville,	89.303	1.900	2.002	.021	4.830
"	"	82.589	5.751	3.367	.063	7.310
"	"	89.857	2.898	1.860	.017	4.520
Mehaffey,	Logansport,	96.453	1.445	.964	.007	.830
"	"	93.214	2.065	1.340	.004	2.220
"	"	93.571	1.324	1.207	.029	3.170
Monroe,	Buffalo creek	94.642	1.574	1.182	.012	1.850
Davis,	Cochran's Mills,	53.750	9.989	7.730	.131	23.840
Putney,	Putneyville,	64.160	1.838	7.450	.305	22.280
P. George,	Clayton Pottery,	94.185	1.483	2.089	.031	2.100
Rhea,	Greendale,	93.246	1.740	1.667	.032	3.420
Jno. A. Colwell,	Mahoning Furnace,	94.721	1.044	1.383	.047	2.300
Laughlin,	Stewardson Furnace,	96.007	1.498	1.462	.034	.790
Ross Reynolds,	Kittanning,	95.567	1.422	.930	.035	2.110

Table No. 3.—Analyses of Fire Clays.

Name of Stratum.	Owner.	Locality.	Silica.	Alumina.	Protoxide Iron.	Titanic Acid.	Lime.	Magnesia.	Carbonic acid.	Alkali.	Water.
Freeport Upper F. C.,	Kier Bros.,	Salina,	51.920	31.640	1.134	1.160	.030	.443	none.	.402	13.490
" "	"	"	47.250	34.350	.693	1.990	.580	.090	.455	.261	13.695
" "	"	"	40.720	37.280	2.448	2.280	.520	.002	.408	.570	15.002
" "	"	"	60.520	24.970	1.650	1.220	.900	trace	.725	.218	9.395
" "	"	"	55.330	27.841	2.916	1.140	.580	.756	.455	3.916	7.495
Ferriferous Coal, F. C.	Stewart,	Kittanning,	55.960	28.415	1.641	1.010	.070	.396	. . .	.615	12.690
" "	Brown & Neale,	Allegheny Furnace,	50.370	32.890	1.641	1.030	.310	.353	. . .	.290	13.760
Clarion fire clay,	Ross Reynolds,	Kittanning,	58.750	25.170	2.195*	1.050	.710	.936	. . .	3.535	8.110
Mercer group fire clay	McCauley,	Anthony's Bend,	44.610	38.010	1.251	1.020	.080	.407	. . .	1.735	13.630

* Protoxide of manganese, trace.

No. XIII in Westmoreland and Fayette Counties.

The *Lower Productive Measures* in these two counties have their greatest outspread in the *Ligonier valley*, between Laurel hill and Chestnut ridge, although there is a belt of considerable width of the same group exposed along the western flank of Chestnut ridge from the Kiskiminetas to the State Line. The whole western portion of both counties carry still higher rocks (Nos. XIV, XV and XVI) as the surface formations, except in two or three isolated spots over the crowns of anticlinal axes to be presently mentioned, where only the uppermost beds of No. XIII are exposed to view.

The *Ligonier basin is geologically deeper** in Westmoreland then in Fayette Co. as a glance at the maps will show; for between the Kiskiminetas and Loyalhanna creeks there remain about a thousand acres of the *Upper Productive Series* and *Pittsburgh coal* in the heart of the basin; an area of the *Barren Measures* co-extensive with the valley; whilst the *Allegheny Coal Series* are shown only on the margins of the trough, along the flanks of the two great boundary mountain ridges. In Fayette, on the contrary, the map coloring shows a much wider area of the *Conglomerate* and sub-carboniferous rocks; the occurrence of the *Lower Productive Measures* in more or less isolated and detached areas, and the total absence of all the *Upper Productive Group* and

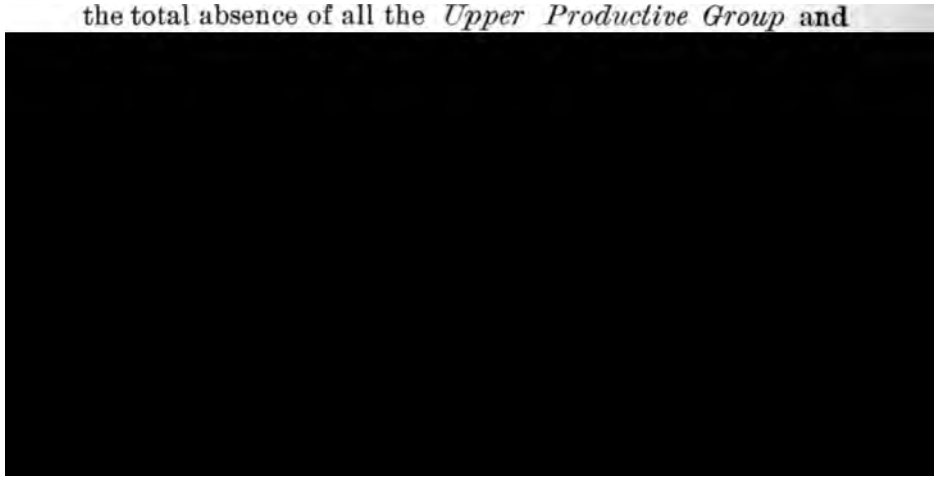
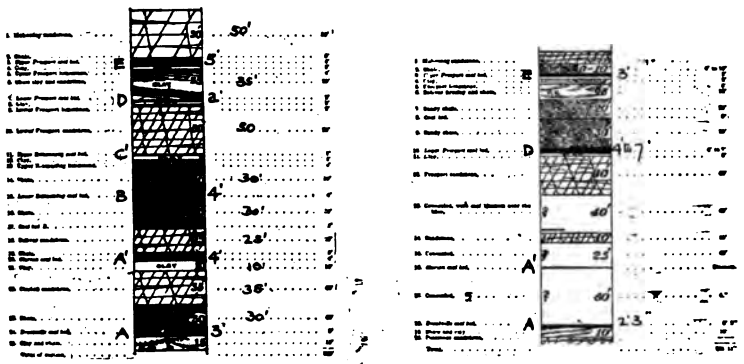


PLATE 452.

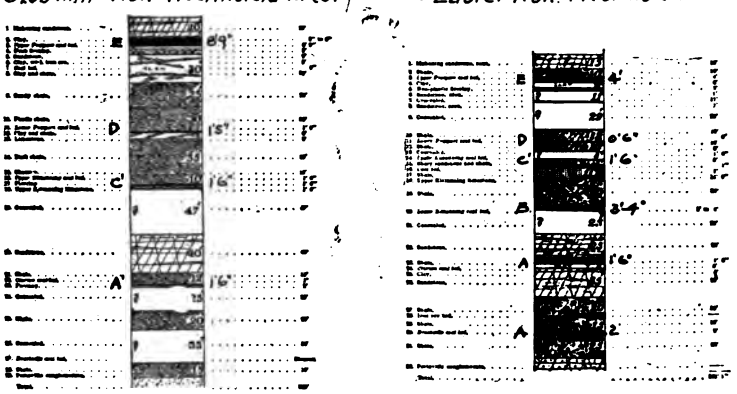
No XIII Allegheny Coal Series. Ligonier Basin Rep K[3]

Westmoreland and Fayette Counties. Pa.

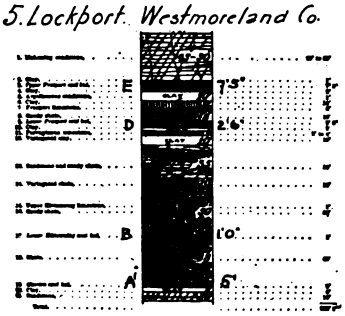
1. General Section Ligonier Valley. 2 Cucumber Run Fayette Co.



3 Tub mill Run Westmoreland Co. 4 Laurel Run. Westmoreland Co.



5. Lockport. Westmoreland Co.



Scale 200'= 1"



great synclinal trough,* the dips within the basin are far from regular and the minor folds are so numerous as to frequently obscure the structure.

The *Lower Productive Coal Series No. XIII* are readily accessible along both sides of the Ligonier valley, and a general section is shown in Figure 1 plate 452, the entire group aggregating about 300′ in thickness.†

The *Freeport upper coal E* is reached within every township of the Ligonier valley; not so accessible however in Westmoreland Co., (where it is confined to narrow strips along the mountains) as in Fayette. It is usually a double bed, sometimes triple, though at a few localities apparently single; the changes in thickness and structure are abrupt. Still it and the *Lower Freeport bed D* are the only good beds of the Lower Productive Series in this entire valley. (For sections see plates 453 and 454).

Along the Youghiogheny the bed is mainly single with only knife edges of slate partings, but occasionally double; south of the National Road it is almost invariably double, both divisions carrying only thin slate partings, sometimes (as on Big and Little Sandy) showing a complex structure. On Grosser run it shows 9′ 7″ thick, the upper division carrying 14 layers of coal and shale, in all 6′ 9″ thick. On Meadow run the bed is double, near the head of the stream 4′ 0″ to 4′ 6″ while near the Youghiogheny river 3′ 6″, including partings, dwindling to 2′ on the river itself.

On Indian creek it is always double, the upper division slightly parted into two benches 1′ 7″ and 1′ 3″ and separated at Ohiopyle Falls from the lower division 2′ 11″ by 1′ of clay. The top bench is usually slaty while the lower is

*The main axis of the trough crosses the Conemaugh below New Florence, the Loyalhanna at Ligonier and the West Newton pike midway between Donegal and Jones' Mills. In Fayette Co. it is deflected eastward so as to cross Indian creek near the mouth of Laurel run, the Youghiogheny midway between the mouths of Jonathans and Bear runs, and the National Road nearly 2 miles west of Farmington.

†Other vertical sections are given on same plate, on Cucumber run, Fayette Co. and on Tub mill run, Laurel run and at Lockport along Penna. R. R. in Westmoreland Co.

prismatic, ordinarily broken by numerous thin binders of clay, soot or pyrites. This structure is maintained northward, though with much variation; thin on Indian creek where the lower bench is sometimes only 1′ 6″ and the clay parting 4″. On Fayette Furnace property the bed varies from 4′ to 7′ within a few yards changing indifferently in this division. On Indian creek, 2 miles from Springfield, the bed is a mass of clay and slaty coal, not less than 12′ thick, soon changing in all directions to its normal character.

Along the base of Laurel hill in Westmoreland Co. the bed has but little value, showing near the head of Indian creek, top coal 8″; clay 1′ 2″; hard shale 8″ and bottom coal 1′ 8″, total 4′. Further north, at the bend of the Loyalhanna, it is in one bench 3′ 6″ to 4′ thick. Thence to the Bedford pike* rarely over 3′; on Tub mill run over 4′, but decreasing in size towards the Penna. R. R. to 2′ 3″ or 2′ 6″. But along the base of Chestnut ridge in Westmoreland Co. this coal is much thicker. In Ligonier the whole bed is from 5′ to 7′ thick, with the upper division double and separated from the lower division by 11″ of clay, streaked with coal. On Tub-mill run in Fairfield twp. the structure shows an upper division 3′ 5″ thick, carrying 2″ of bony coal a foot from the the top; parting 9″ and lower division 4′ 6″; but on the Penna. R. R. in the same township the upper division is 5′; the parting 2′ and the lower division 2′ 3″. The upper division always shows brilliant coal, in thin layers; the lower division dull, broken

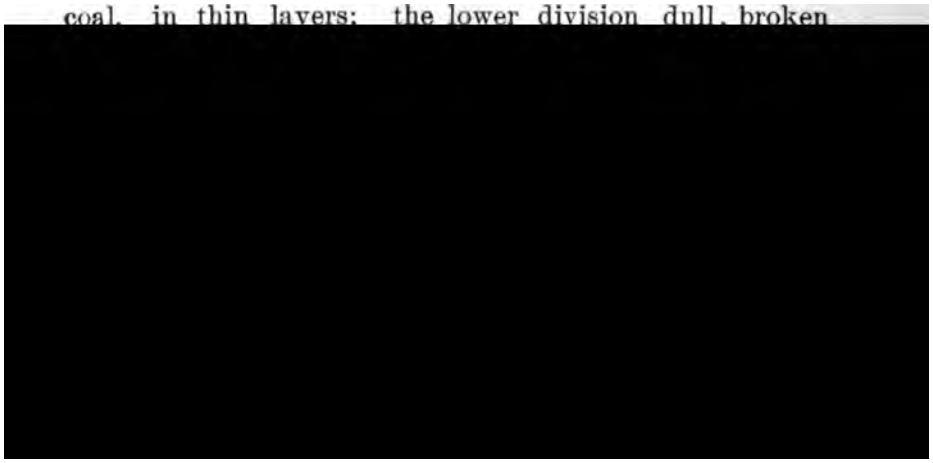


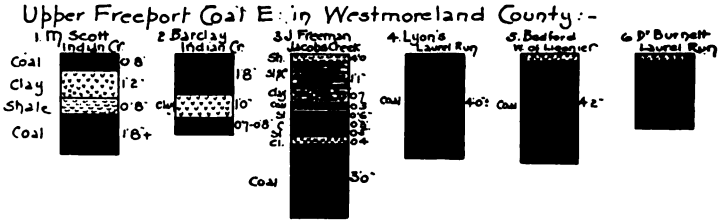
PLATE 45B.

No XIII. Allegheny Coal Series in Westmoreland and Fayette Co Pa.

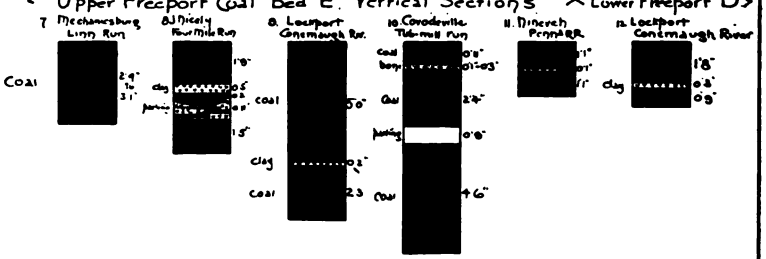
Coal-bed Sections in the Ligonier Valley Basin.

J.J. Stevenson

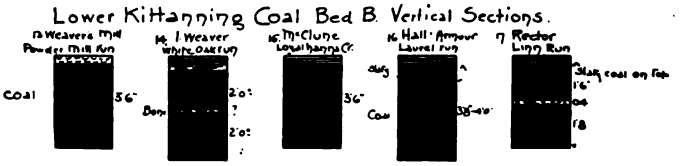
Upper Freeport Coal E: in Westmoreland County:-



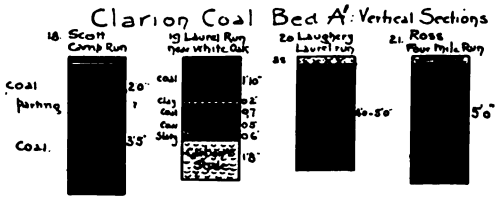
Upper Freeport Coal Bed E. Vertical Sections. × Lower Freeport D.



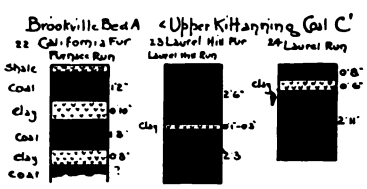
Lower Kittanning Coal Bed B. Vertical Sections.



Clarion Coal Bed A': Vertical Sections



Brookville Bed A < Upper Kittanning Coal C'



Scale 1" = 8"

E. Kdl.



The *Freeport upper limestone* occurs from 5′ to 15′ beneath its coal and varies from 0′ to 18′ in thickness.* It varies in quality as it does in thickness. Most frequently it carries a thin top layer of dark blue impure slaty worthless limestone, the balance being a dull bluish-grey stone, more or less argillaceous, with irregular fracture. It burns slowly and yields a fairly good fertilizing lime. Sometimes it is ferruginous at the outcrop and was mined as iron ore at Laurel Hill furnace.

The *Freeport upper fire clay*, which occurs a short distance below the limestone, is well known as the "*Bolivar fire clay*", and has enjoyed a high reputation as a plastic clay from its typical development at Bolivar on the Penna. R. R. It is widely distributed but not always persistent or regular.†

Productive Measures, all testifying to the irregularity of the measures both in section and characteristics; but these features are sufficiently illustrated in page plates 453 and 454 not to require specific mention of them in this report.

*This, which in the *Final Report* of 1858 is termed the "*Freeport limestone*," is not wholly persistent though it is present at a large proportion of the localities where its horizon is exposed. In Henry Clay twp. on both sides of Laurel ridge; in Wharton twp. more than 10′ thick near State line on Big Sandy, but is wholly wanting near Wharton furnace and on National Road. Along Meadow run and throughout western Stewart it is persistent; 6′ thick on Meadow run, 18′ on river hill above mouth of Jonathan's run and only 3′ at northern edge of township. North from the Youghiogheny irregular, being 9′ near Ohiopyle, 3′ to 5′ near Springfield, but of uncertain occurrence near Fayette furnace. North from Springfield present to county line, but thence along Indian creek in Westmorelend Co. it seems to be unknown.

Following up the base of Chestnut ridge this limestone is fully 10′ thick in Mount Pleasant twp., 11′ on Four mile run and of unascertained thickness on Loyalhanna; but on Tub-mill run in Fairfield twp. clearly wanting, while on Penna. R. R. in same township it varies from zero to 10′. Along base of Laurel ridge, absent or nearly so south from Bedford pike, but at the pike some fragments of it were seen. On Hendrick's run 11′ thick; on Tub-mill 14′ but only 3′ 6″ on Laurel Hill run while on the Penna. R. R. it is wanting.

† In Wharton twp. of Fayette this clay near Wharton furnace is 10′ thick, light blue and contains many nodules of clay iron-stone. This is its character throughout the township. In Stewart fully persistent and 8′ thick along river hill where it contains huge balls of iron ore. On Indian creek in Springfield twp. 4′ thick. In Westmoreland Co. seen at few localities south from Bedford pike; exposures do not admit of measurement. On

The *Freeport Lower coal D** is usually concealed in southern Fayette along the West Virginia line; but at one locality on Little Sandy it yields good coal 4′ thick. In Stewart twp. along the Youghiogheny river it is everywhere present, and while subject to great variations, it is an important source of local fuel supply. On Meadow run it is from 1′ to 5′ thick, poor when thickest, whereas along the Youghiogheny between the Ohiopyle Falls and the mouth of Jonathan's run it shows top coal 2′ 3″, clay 4″ and bottom coal 3′ 4″. But half a mile away it is a worthless mass of coal and clay, with a top bench 1′ 6″, clay 5′, coal 1′, clay 2′ 6″ and coal 1′ 6″. Northward in Fayette it becomes unimportant, rarely exceeding 1′ 6″; but in Mt. Pleasant twp. of Westmoreland it shows 3′ 6″ on the clay pike, only to dwindle to 6″ near Laughlinstown in Ligonier

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Laurel run in Ligonier twp. 2′ thick. North from the Loyalhanna unobserved along east side of valley, but on west side persistent from southern boundary of Fairfield twp. to Conemaugh river.

The clay is subject to annoying variations. At Bolivar it is embedded in a mass of shale and varies from 3′ to 12′. Often it is cut out by plastic clay or by ordinary shale, while at one place it ends abruptly against a wall of hard sandstone. The quality seems to be quite stable. Analyses of two samples were made by Mr. A. S. McCreath, as follows:—

I. Ligonier twp., Westmoreland Co.

II. Stewart twp., Fayette Co.

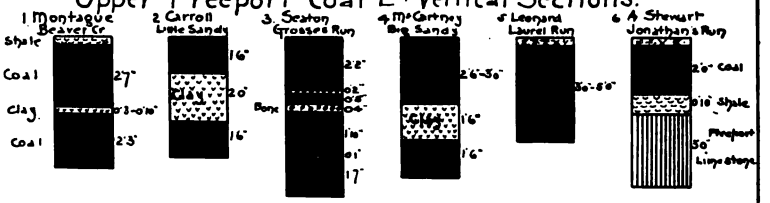
Bolivar Fire Clay Samples.	I.	II.
[redacted]		

PLATE 454.

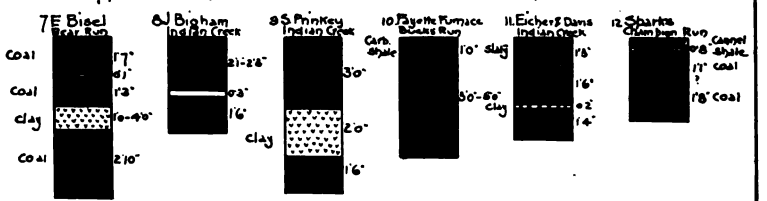
No XIII. Allegheny Coal Series in Fayette Co. Report K³

Coal-bed Sections in the Ligonier Valley Basin.

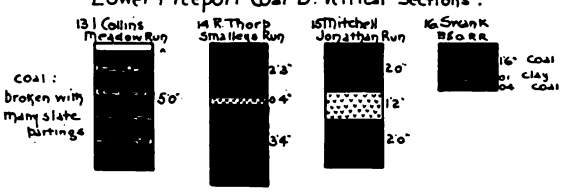
Upper Freeport Coal E: Vertical Sections.



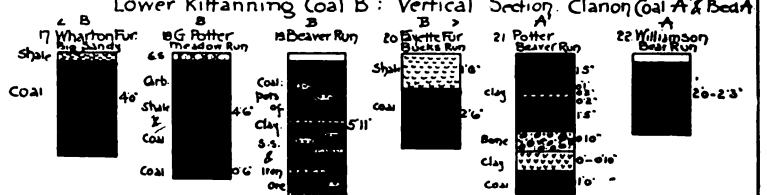
Upper Freeport Coal E: Vertical Sections



Lower Freeport Coal D: Vertical Sections.



Lower Kittanning Coal B: Vertical Section. Clarion Coal A' & Bed A



Scale 1"=8'

Ekd'l.



twp. In Fairfield it is 1′ 5″ on Tub-mill run and 2′ 8″ on the Penna. R. R., with 3″ of clay 9″ from the floor. Sections of this uncertain bed are given in plates 453 and 454.

The *Freeport lower limestone* is rarely present in this district and plays no part in the economic resources of the valley; still it is present in the west end of the Youghiogheny gap through Chestnut ridge, 4′ below its coal and 2′ thick. In Westmoreland Co. it shows on Tub-mill run 6′ below its coal and 3′ thick and ferruginous; and on the Penna. R. R. 2′ to 4′ thick and 3′ beneath bed D. The Freeport sandstone thus often lies quite close to its coal. In lower Fayette it is present on Little Sandy, Meadow and Beaver runs and along the river, occurring in cliffs 40′ to 50′ thick, compact above and flaggy below, with vast numbers of rude vegetable impressions near the base. Frequently it is a fine grained sandstone and is largely used for building purposes. North of the Youghiogheny the rock is flaggy and beyond Springfield twp. its presence is uncertain. Near Laughlinstown it has dissappeared entirely and the reduced interval of only 18′ between coal beds D and C′ is entirely filled with shale. On the Penna. R. R. this interval is occupied by 35′ feet of sandstone and shale while on on Tub-mill run the sandstone is wanting as in St. Clair township.

The Kittanning Group in the Ligonier Valley.

The *Kittanning upper coal C′* seems to be wholly wanting in Fayette. On Loyalhanna creek in Westmoreland county it is fairly persistent along Laurel hill, with its best development at Laughlinstown, where it shows 1′ 8″ thick. Along the railroad it is found again 1′ 6″ thick on Tub-mill run and 5′ thick in St. Clair, where it is mined. The interval up to the Lower Freeport coal varies from 18′ in Ligonier to 54′ on Tub-mill run and 28′ in St. Clair. The coal has little if any significance in the district.

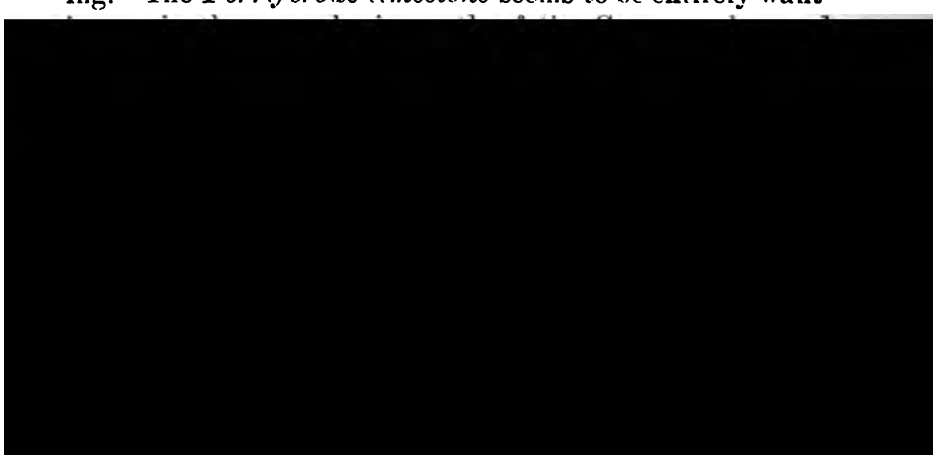
The *Johnstown cement* is also confined to the northern part of the district, and always uncertain. A mile above Fayette furnace on Laurel run it is 8′ thick, but entirely

wanting at the furnace and to the south. Near the Conemaugh the rock is present as a hard thin limestone along the east base of Chestnut ridge. Along Laurel ridge it occurs with less irregularity, though often wanting, especially through Fairfield and St. Clair townships. Still it is frequently quarried for lime-burning for agricultural use.

The *Kittanning middle coal C* is never prominent and at best is merely a streak of impure coal throughout the district.

The *Kittanning lower coal B* seems to be persistent everywhere but in St. Clair township of Westmoreland county. In Fayette county this coal was found on the Little Sandy, Cheyney run and Big Sandy near Fayette Springs, varying from 2′ 6″ to nearly 6′, with a layer of compact carbonaceous shale as a top bench. In Stewart township it is a worthless mass of shale with 6″ of coal at the base; as bad on Beaver run, but yields a fairly good coal in Springfield.

In Westmoreland county it is absent along Chestnut ridge, but a bed of considerable economic importance on Laurel hill, where it is thicker and better than bed E. It here shows 3′ 6″ to 4′ thick, and in all the pits a slaty layer on top and an obscure parting near centre; hard coal in the upper bench and soft prismatic structure below the parting. The ash is considerable and sulphur annoying. The *Ferriferous limestone* seems to be entirely want-



In the *Blairsville basin* the important beds of the Lower Productive Series are available along the western slope of Chestnut ridge. They have however been almost totally ignored in the presence of the thicker and better *Pittsburgh coal* in the heart of the basin. The coal of the *Upper Freeport* and *Brookville beds* is however of very good quality, almost as clean as the Pittsburgh coal, and only inferior to it in respect of sulphur; and the Upper Freeport bed especially shows but little serious irregularity in thickness. Where exposed by erosion on Big Sewickley creek in Westmoreland county it shows from 2′ to 5′ thick; on Little Sewickley south of Grapeville it is a double bed, with coal 3′; clay 2′ 6″ and coal 5′; total 10′ 6″. On the Loyalhanna and Conemaugh it is from 3′ 6″ to 5′ thick in a single bench along the Saltsburg axis; and from 4′ to 8′ thick under the Murraysville axis.

The maximum thickness of the Lower Productive group, according to the general section plate 455 fig 6, is 313.* The different rock members vary greatly. The *Mahoning sandstone* on top is generally persistent as sandstone (though sometimes shales); very often double, holding a coal between the two members. The rock is commonly more or less coarse-grained.†

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*K. K. By Dr. J. J. Stevenson 1875. Excluding the Mahoning sandstone in southern Fayette the group is rarely more than 150′; some localities not more than 125′. North of the Redstone the thickness increases and becomes 270′ on the Youghiogheny. Sections are given on plate 455, also illustrating condition of No. XI ore group; No. XII and No. XIV measures.

†The *Johnstown ore bed* comes 60′ above bed E in lower Fayette, with interval sandstone. Also 60′ on Redstone in Chestnut Ridge with coal 25′ above top. In North Union barely 35′ thick, coarse and flaggy, and a single mass without coal on top. In Dunbar again double, divisions 35′ and 40′ thick, and coal bed between nearly 3′ thick. Northward sandstone diminishes, and in Mt. Pleasant at head of Jacobs creek, interval between bed E and Johnstown ore bed is only 35′ and is all shale. In Derry and Unity twps. of Westmoreland 40′; under Blairsville arch only on the Loyalhanna, flaggy and obscure; but under Saltsburg and Fayette axes the Mahoning sandstone shows on every important stream crossed north of the Redstone. First as shale; on the Youghiogheny as sandstone 50′ thick; the same on Jacobs creek, and as 40′ of flaggy sandstone on Sewickley. On Little Sewickley it is again largely shale 35′ thick, and as sandstone on Beaver run and the Conemaugh under Murraysville axis, nearly 50′ thick.

The *Freeport upper coal E* is always present where its horizon is reached, but rarely as merchantable coal, and excessively variable in thickness. Still it has been widely mined for local use along Chestnut ridge, where the *Pittsburgh coal* is absent and distant, from the Conemaugh to the State line. It is commonly double, in Spring Hill twp. of Fayette showing two main benches, top 2′ 0″ and bottom 3′ 6″, separated by 1′ 6″ of hard clay. Above this bed proper there are streaks of coal, clay and slaty coal for nearly 10′, the whole mass being 17′ thick.

In Georges twp. the upper bed consists of 3′ of black shale, containing streaks of coal, while the lower division is 9′ 4″, of which a bottom 3′ bench is separated from the rest of the bed by 8″ of clay. This feature also shows in South Union, above which is 1′ 4″ of hard clay, and then the upper division, separated by clay partings into 4 benches. The bed maintains this character and thickness to the National pike; then thins rapidly to Cove run where it is from 2′ 0″ to 3′ 6″. In Dunbar the ordinary character of the bed shows as follows: coal 2′; clay 3′; coal 5′ 8″; total 10′ 8″. At Connellsville the upper division is 2″ and lower division 6′, with 1′ of clay between. On Jacobs creek in Mt. Pleasant the upper division shows 3 worthless layers of coal and black slate and the lower division 3′, which is alone mined. On the Loyalhanna in Derry only the lower division seems to be present, but further

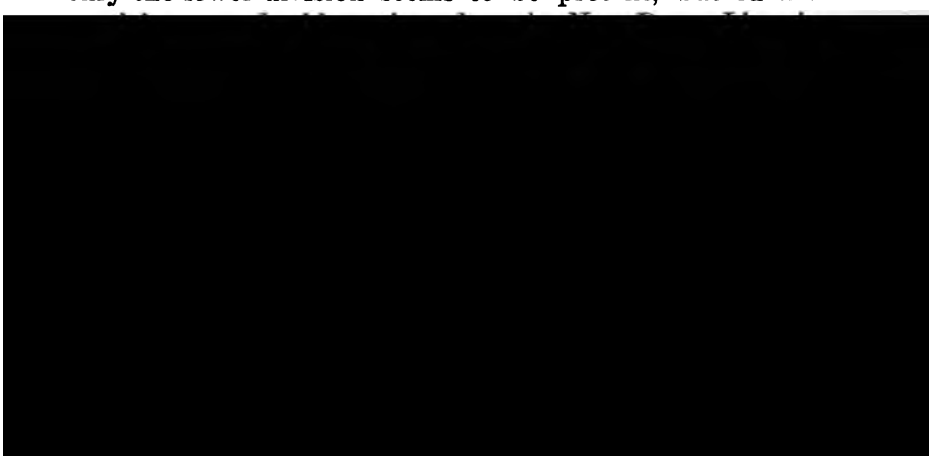


PLATE 455.

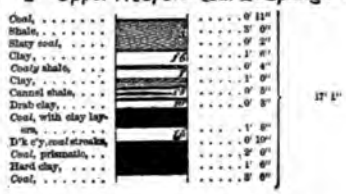
No XIII. Allegheny Coal Series west of Chestnut Ridge

Westmoreland and Fayette Co's

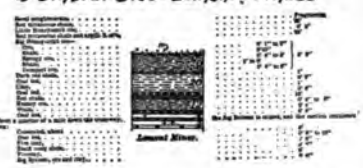
1. General Section, Spring Hill Furnace.



2 Upper Freeport Coal E: Springhill



3 Umbral Ores: Lemont Furnace

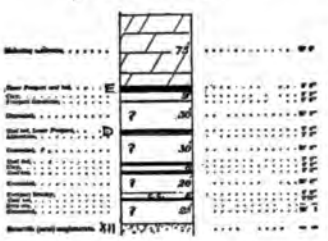


4 Mt Savage (No XII) Coal: N. Union Twp.



5. Allegheny Coal Series.

Dunbar Twp: Fayette Co.

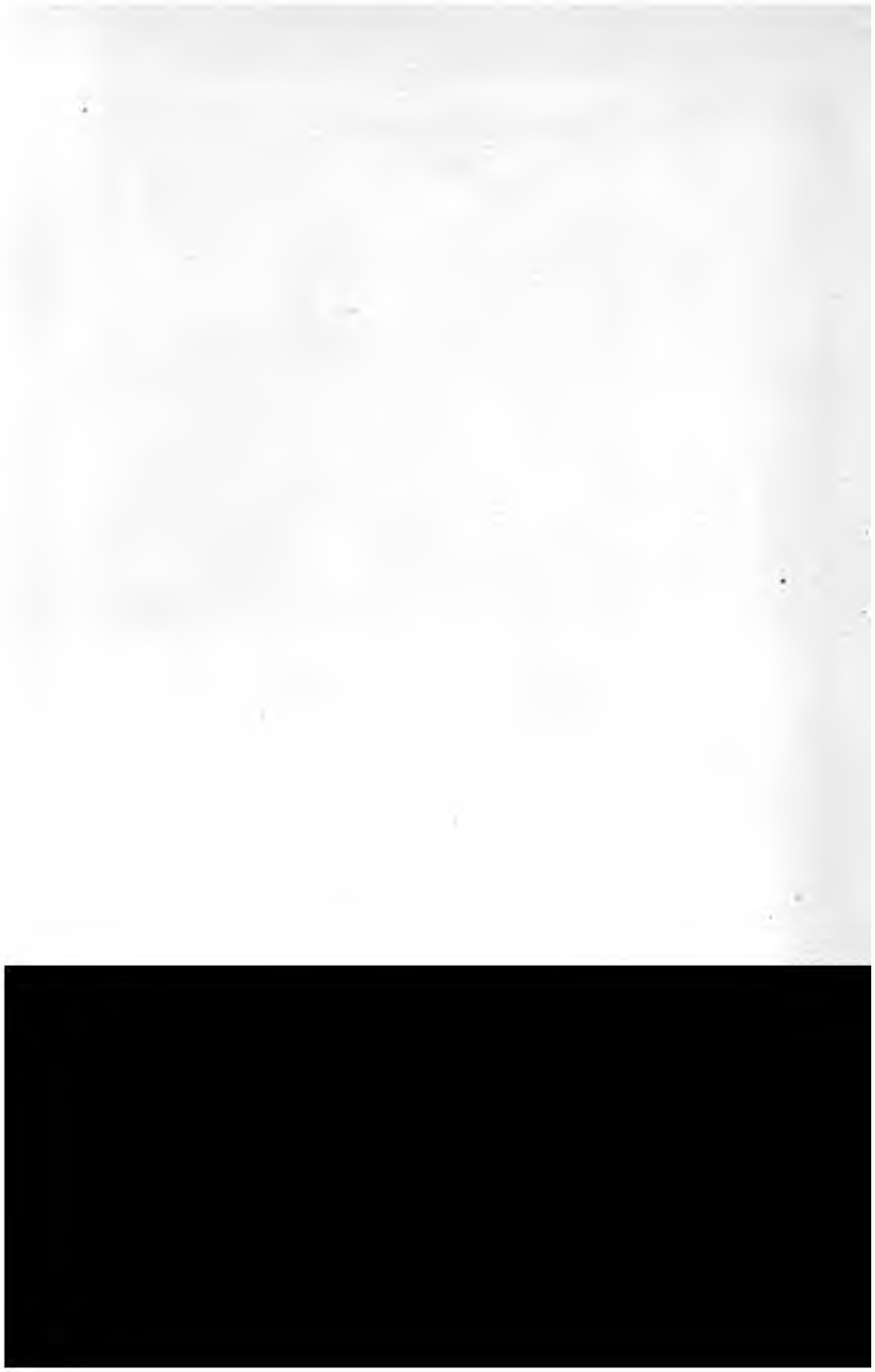


6. General Section No XIII: W of Chestnut Ridge.



No XIV. Barren Measures: New Geneva.





into a number of thin partings rather than showing two principal members and is from 2′ to 5′ thick. On Little Sewickley it is again double and swollen to show coal 3′; clay 2′ 6″; coal 5′. On the Loyalhanna and Conemaugh it shows a single bed, 3′ 8″ to 5′ 0″ thick.

Thoughout its wide outcrop along Chestnut ridge its economic value is slight, and while thick in places and for the most part having a regular roof and floor and no troubles from clay veins and horsebacks, it is very generally inferior, only attaining excellence in isolated districts. It is apt to hold a considerable percentage of sulphur, while being otherwise perfectly acceptable; with 34% volatile matter and 56% fixed carbon.

The *Freeport upper limestone*, 6′ to 10′ below its coal along Chestnut ridge, is a blue and somewhat earthy rock often pure enough for agricultural lime. On Big Sewickley it is 1′ 6″ thick and 12′ below bed E and on the Loyalhanna 5′, of excellent quality and only 5′ below the coal. On the Conemaugh 3′ to 5′ and only 3′ below the coal bed; cream in color, argillaceous and good.

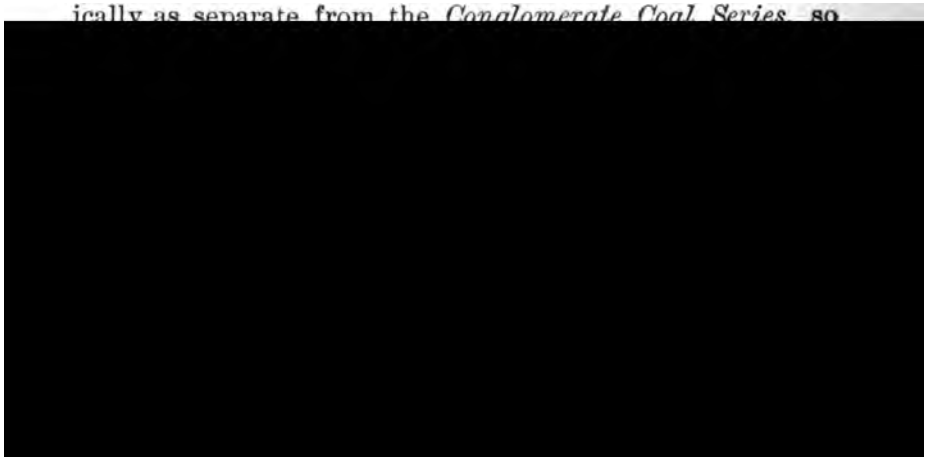
The *Freeport lower bed D*, the great "Moshannon bed" of the Clearfield and North Cambria district, is here most uncertain and unreliable. In Springhill 3′ 10″ thick it is nevertheless divided into 3 benches of impure coal by thin layers of clay. At Dunbar furnace 2′ 6″ and generally wanting along Chestnut ridge in Westmoreland Co. It is wanting too on the Youghiogheny, but somewhat important, if variable in thickness and quality, on Sewickley creek. On the Loyalhanna it is fair and 3′ thick and on the Conemaugh generally thin and absent.

Of the measures beneath this coal bed no reliable section can be obtained. They are beneath water level to the west of Chestnut ridge, while along that mountain flank they are largely concealed by *débris* from the conglomerate cropping above them. In Springhill coal 4′ (?) thick is found 30′ below bed D and underlaid by 2′ of ferruginous limestone, partially identifying it as bed C′; but this is

mere conjecture and the entire lower part of the series is obscure.*

In *Burrell* and *Allegheny twps.* of Westmoreland Co. along the Allegheny river the *Mahoning sandstone* and *Freeport group* of coals are exposed. The Mahoning is a massive rock, forming bluffs from Lockhart to Freeport, 50′ thick. The Freeport upper bed E crops in the river below Lockhart and keeps in sight to above Chartiers station, where it rises still more rapidly to the Conemaugh. It is often capped directly by the Mahoning sandstone which renders it exceedingly irregular. Above Tarentum it is nearly 8′ thick, in two divisions, separated by fire clay, quite similar to Chestnut ridge and about 6′ below the sandstone. The upper division is poor. Again the sandstone cuts out the upper division and sometimes the entire bed, so that great variations, from 0′ to 8′, occur within short distances. Its limestone 3′ to 5′ thick underlies the coal 1′ to 4′. The Freeport lower D is just as unreliable as along Chestnut ridge, best at McKane's station, 4′ thick, in two benches; coal soft but good. Beneath it the Freeport sandstone frequently shows 40′ to 50′ thick, massive and good.

The *Lower Productive coal measures* in the north-western corner of the State are confined entirely to Clarion, Butler, Mercer, Lawrence and Beaver Cos., and even in these districts it is difficult to subdivide and describe them economically as separate from the *Conglomerate Coal Series* so



both of the overlying Kittanning coal beds; but the amount of workable coal therein contained is very small and has mainly sufficed to run the engines at the oil wells.

*No. XIII in Clarion County.**

Clarion is essentially a coal bearing county, for its surface rocks are everywhere the *Lower Productive coal measures* or the *Conglomerate measures* with the exception of a very narrow strip along the valley of the Clarion river north-east of Clarion, where the *Mauch Chunk red shale No XI* and *Pocono Sandstone No. X* are exposed for several miles.

The Brookville anticlinal, *Fourth axis* of the First Survey, just touches the south-eastern corner of the county, while the great Brady's Bend anticlinal or *Fifth axis*, is a well marked arch entering from Jefferson Co. with the Clarion river and leaving it at the mouth of the Red Bank on the Allegheny river.†

The *Lower Productive coal measures* vary from 325′ to 350′ thick, with an occasional and exceptional diminution to less than 300′, always *excluding* the Mahoning sandstone and shales between it and the Freeport upper coal. Differentiating the generalized section given on plate 456 fig 1,

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* Report V 2. H. M. Chance 1880. The report is accompanied by a handsome geological map upon which there has been placed a general vertical key section of the various rock groups. The *Barren Measures*, overlying the coals, are here represented for the last time in north-western Pennsylvania by detached areas on the hill summits north of Red Bank creek; but none such are shown on the map to extend north of the Clarion river. They form the last remnants of a mass of shales, slates and sandstones, generally barren of either good coal or good limestone, which create the surface rocks, from 600 to 1000′ thick, in the district lying between the Allegheny mountains and Chestnut ridge and which lie deeply buried beneath water level through a very large area in the southwestern corner of the State. In Clarion Co. the last outliers of this formerly extensive formation are left in small patches to attest the fact of its having spread perhaps much further north.

† The surveys of Mr. Chance however showed the necessity for introducing both the Anthony Bend and Kellersburg anticlinals into the Fifth basin and the Millerstown anticlinal into the Sixth basin, at the same time giving additional names to the synclinal troughs between these several axes.

the Freeport group is 135′ thick; the *Kittanning group* 120′ thick, and the *Clarion group* 80′.

In comparison with the geology of the northern coal counties lying to the east of Clarion, the student will notice two things particularly; *first*, the very much greater importance which the Freeport group assumes in this district and *second*, the occurrence of the Brookville coal bed at the base of the Clarion group, which seems to have no representative to the north-east.

Typically the Freeport group contains two coals, two limestones and two sandstones; but Mr. Chance states that he never found all the members of the group present at any one locality in the county, so that the group varies from 120′ to 145′.

The *Freeport upper coal E* is found only in the summits of Madison, Toby, Perry, Porter and Red Bank twps., being elsewhere eroded. In Madison and Toby twps. the bed ranges from 2′ 6″ to 4′ 3″, but is often entirely cut out by horse-backs and squeezes. It was mined for the Red Bank aud Sarah furnaces, mostly from the summits overlooking the river above Brady's Bend, and was coked in open hives at the pit mouth. The coal is too sulphury and slaty for good coke without extraordinary care.

In Porter twp. this bed shows an excellent coal remarkably free from sulphur and unusually thick. It was used in the raw state some years ago by the St. Charles furnace. It shows 4′ 0″ to 4′ 9″ of workable coal; contains no slate

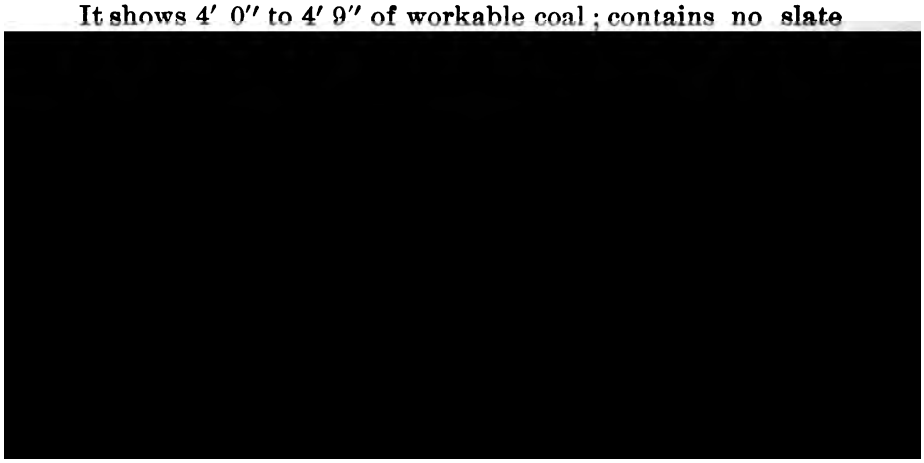
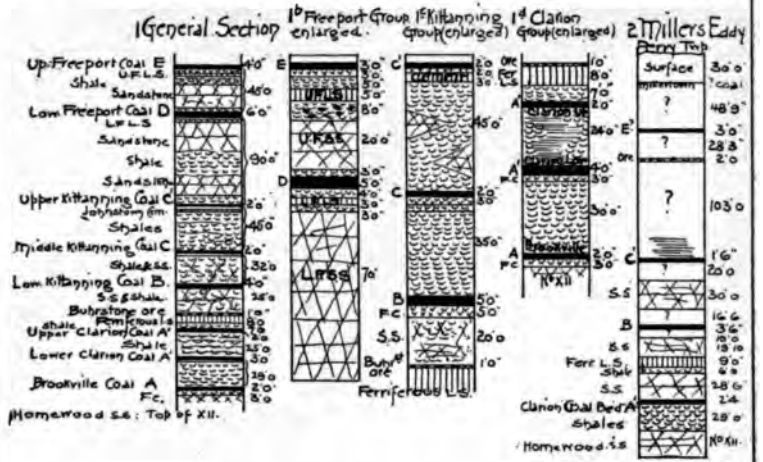


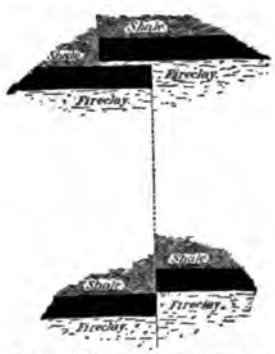
PLATE 456.

No XIII. Allegheny River Coal Series in Clarion County.





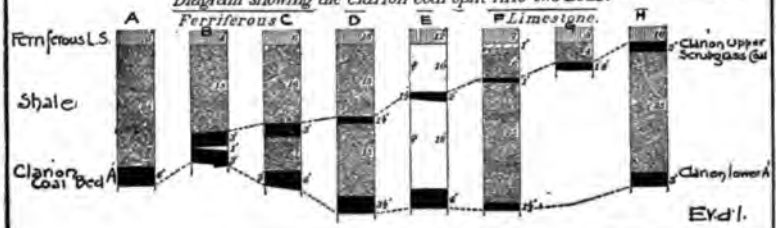
Sections showing
A Fault in the Kittanning Lower Coal
near Strattonville, Clarion Co. Pa.



A Normal Sect. South of split. B-F. Sections along a line from Martinsburg, Butler Co. to Edenburg, Clarion Co. G. Emlenton Venango Co. H. Normal Section North of split.

B Martinsburg. C. Bear Cr. D Parker. E W. Freedom F Edenburg

Diagram showing the Clarion Coal split into two Beds.



Eyd'l.

The *Kittanning upper coal C'* is not reported to reach workable size or quality in the county, although it has been repeatedly opened at several places in Red Bank twp. and prospected upon at many other points. At the Bostonia mines near New Bethlehem in Armstrong Co. this bed carries an upper bench of cannel coal averaging 7′ in thickness; and it partakes of a cannel structure in many other parts of the state though never so in Clarion Co.*

The *Johnstown cement seam* underlying this coal has been found exposed at but one locality in Clarion Co., on Middle run north of the Fairmount Coal Co.'s opening on the lower Freeport coal; but its identity here with the well known seam around Johnstown in Cambria Co. has proved of the greatest importance and value in determining the identity of the coal measures and removing the very great uncertainty which existed prior to the work of the Second Survey in the minds of many geologists.

The *Kittanning middle coal C* is a somewhat better seam than the Kittanning upper which it underlies about 45′, where opened at a few banks in the southern row of townships; but it is generally too thin to mine, showing a section at Summersville bank in Toby twp. of about 3′ of workable coal in two benches, 2′ and 1′ thick, separated by 1″ of slate. It is possible that some areas may be found in which this bed will be of workable size; but much prospecting at its horizon has generally yielded disappointing results.

The *Kittanning lower coal B* has a wide outspread

At Catfish it shows 4′ 6″ thick and in the main the tripple bed section which so generally characterizes this coal seam throughout Pennsylvania, although here the two slate partings are not over an inch thick and the coal benches 1′ 2″, 1′ 10″ and 0′ 6″ thick. In this vicinity and at Fairmount it is highly prized as a steam coal, although it carries very nearly 2% of sulphur.

At *Fairmount* it is 4′ 11″ thick with benches 2′ 4″, 1′ 0″, 1′ 0″ and separating slates 2″ and 1″ thick, carrying 4″ of slaty coal on top. Going north the bed decreases in size, rarely exceeding 3′ in the northern townships, with an average of 2′ 8″. At the openings worked by the *Sligo Branch Coal Co.* near Reimersburg, the bed is 3′ 6″ thick with only one thin 1″ parting near the middle, separating benches of 1′ 8″ and 1′ 9″, although the bed in this vincinity is rather variable, rapidly changing in size from 3′ 3″ to 4′ 6″. In Red Bank, Porter, Madison, Piney, Toby, Monroe and Limestone twps. broad tracts of it remain in an almost undisturbed state and a suite of 9 analyses of this seam all show a large precentage of volatile matter, varrying from 35.695% to 41.575% and a comparatively low precentage of ash from 2.265% to 8.160% although it has, as a drawback to this excellent quality, a considerable percentage of sulphur, ranging from .818% to 3.789%. The bed is very favorably situated for mining on Town run and near Shannondale in Red Bank twp. and is generally accessible from the Low Grade R. R.

A curious fault in this seam has been developed on the crest of the Brady's Bend axis near Strattonville, illustrated on plate 456. A break of 3′ brought the floor of the coal in one part of the Young bank in direct continuation with the roof on the opposite side, the broken edges overlapping so that for a distance of 5′ the bed was double and furnished 6′ of coal, in which a parting of 6′ of slate was found adhering to the roof of the lower layer. In every case the edges were sharp, well defined cross-breaks.

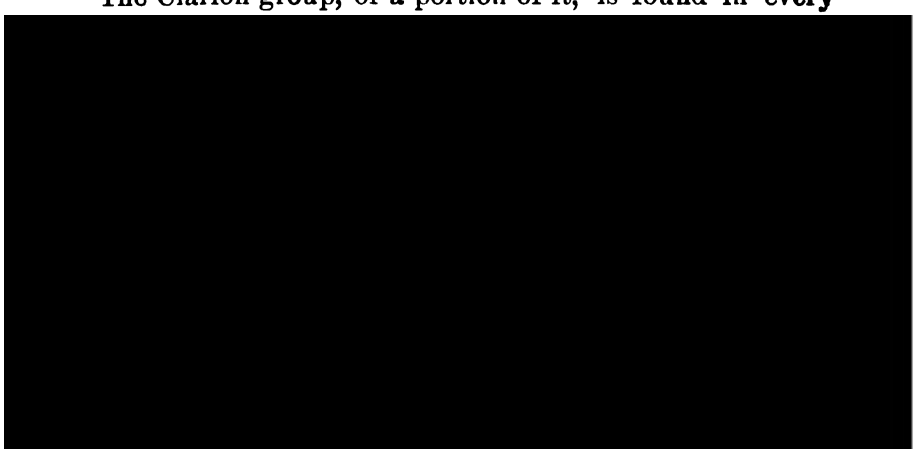
The *Clarion group* in the southern part of the county as well as in Armstrong and southern Butler consists of the

Ferriferous limestone and two underlying coal beds; but in northern Butler, northern Clarion and Venango Co.'s it contains three coal beds.

An illustration, plate 456, shows a suggestive series of sections of this group taken along a line north-eastwardly from Martinsburg in Butler Co. to Edenburg in Clarion Co., showing the gradual spliting of the bed from the south northward. The *normal* arrangement of the group south of the split shows a coal bed 4′ thick separated by about 25′ of shale from the overlying Ferriferous limestone 5′ thick, and the succeeding sections show this bed gradually splitting into two seams, the upper and thinner split gradually approaching the limestone until north-east of Emlenton, the upper split 2′ thick immediately underlies the limestone, separated by 25′ of shale from the lower split 3′ thick. In this region the Clarion upper coal is sometimes known as the "*Scrubgrass Seam.*"

The *Brookville coal*, which ordinarly lies from 30′ to 50′ beneath the Clarion lower coal, is not shown on this plate; but north of the split it occures as a seam about 3′ thick. This structure of the group however is not by any means constant. At many localities in northern Clarion and northern Butler the Brookville coal finds no place in the series, being cut out by the Homewood sandstone; and this condition of affairs largely exists through Cameron, Elk, Forest, Tioga and Potter Co.'s to the north-east.

The Clarion group, or a portion of it, is found in every



to 2′ thick. Its area in the county is indicated on the geological map by a blue line which represents in Clarion more than 450 lineal miles of actual outcrop. The overlying ore bed rests directly upon the limestone, in exceptional localities from 2′ to even 6′ thick but ordinarily measuring an average of 10″. Four analyses of it show 95% of carbonate of lime, about 1% of carbonate of magnesia, the same amount of oxide of iron and alumina, phosphorus .023% to .081% and insoluble residue from 1% to 2%.

The *Clarion upper coal* is rarely workable but always furnishes coal of good quality. At Edenburg it is a little over 1′ thick, at West Freedom 2′, and at Disler's in Venango Co., 18″ thick; South of Edenburg and West Freedom it coalesces with the Clarion lower coal and is therefor practically absent as a distinct bed from the central and southern parts of the county.

The *Clarion lower coal*, though rarely a good seam, is mined at many localities in the northern and central portions of the county, showing better coal in Farmington wp. than elsewhere, and in the southern townships it is very thin and poor. In Perry twp. it is 3′ 7″ thick, in three benches 0′ 11″, 1′ 0″ and 1′ 5″ thick separated by two bone partings 1″ and 2″ thick,

The *Brookville coal* is an almost worthless bed in this county. Approaching its area of good development in Jefferson Co. it becomes a workable seam in Mill creek and Limestone and parts of Clarion, Highland, Paint and possibly Farmington twps., measuring from 2½′ to 4′. It is of better quality here than in the central and western townships, where it is little more than a bed of bituminous shale; but at best it is a poor bed and so variable and unre-

---

bluish steel color. Though characteristically fossiliferous its fossils are seldom visible in the body of the rock. This is because the individual shells, crinoid stems, etc., are so firmly united together in the body of the rock that they fracture with it in any direction. But the fossils are sometimes beautifully weathered out on surfaces of the rock exposed to aerial action; because the fossils are more or less crystalline in structure and resist the solvent action of water charged with carbonic acid, whereas the amorphous calcareous matter in which they are imbedded is much more soluble.

liable that it need not be looked upon to supply any large quantity of good coal.

*No. XIII in Butler County.**

The Brady's Bend, or *Fifth Anticlinal axis*, courses through the south-eastern corner of the county, while the Harrisville axis occupies a similar position in the north western part, coming through Clintonville in Venango Co., passing a little east of Centerville and extending into Lawrence after crossing Muddy creek a short distance above its mouth. Its resulting synclinal lies to the west between it and the Wolf Creek branch of Slippery Rock creek.†

The *Lower Productive Coal Measures*, nearly horizontal, crop out along the main valley of the Connoquenessing creek and its larger branches, and rising northward in obedience to the general structural law of this portion of the State, they take possession of the middle and northern townships until in their turn they are cut through by the many branches of Crooked creek, along the steep side slopes of which the *Conglomerate Series No. XII* crops out with its two little Mercer beds and limestones; its Quakertown seam and its Sharon coal bed (of no importance in this county).

The *Ferriferous limestone*, carrying its "*Buhrstone iron ore*," crops out on both sides of Muddy creek; all along the Crooked Creek valley and its branches and along the valley slopes descending to the Allegheny river in

PLATE 457.

No XIII. Allegheny Coal Series in Butler County.



A general section of the *Lower Productive Coal Measures*, with its extremes, is given in plate 457; but no complete section can be well obtained within the limits of the county.* The Freeport sandstone ranges from 36′ to 60′ in thickness; but this variation is always compensated for by an opposite variation in the overlying or underlying strata; so that the distance from the Freeport limestone down to the Kittanning upper coal, or to the Ferriferous limestone remains nearly constant. Between the Freeport upper coal and the Ferriferous limestone there is a mean interval of 264′ at Brady's Bend, which agrees closely with results obtained by Mr. White as follows: at Kittanning 261′; at New Brighton 263′, and at Smith's Ferry 242′. This thickness is sometimes diminished by an apparent replacement of the Mahoning sandstone and the Freeport upper coal and limestone by the shales of the Barren Measures. The rapid deterioration of the Freeport group north, west and northwest from Brady's Bend would seem to indicate the northwestern limits of these coal beds. The Freeport upper coal in this region is seldom workable, and is often apparently absent. In the southwestern part of the county it is never valuable, and in Beaver Co. it is always a thin bed and can rarely be seen. East and southeast from Brady's Bend the Freeport group has its best development and continues as a valuable coal bearing series southward to the State line and eastward to the face of the Allegheny mountains.

Northern Butler. The *Freeport upper coal E* is locally a workable bed at several localities in Oakland, Donegal, Clay and Concord twps.; but elsewhere in this district it is almost a worthless bed and nowhere has a thickness or quality comparable with its exhibit at Brady's Bend. (See plate 460.)

The *Freeport lower coal D* is also very irregular and unreliable, its greatest thickness being found in Clay, Concord, Washington and Parker twps. In some localities in

* Vertical sections and coal bed measurements are given in plates 457-8-9 and 460.

the two latter townships it has an enormous local thickness, measuring as much as 14′ and 16′; but only a portion of the whole bed is good coal for mining. In Clay twp. it is usually about 5′ thick and always in two nearly equal benches, parted by about 1′ of slate. Over the remainder of this northern district it is generally of poor quality, but seldom more than 2′ thick, and is opened in very few places.

The Freeport lower sandstone (the "*Freeport Sandstone*" of the First Survey) can be recognized throughout the whole district; thickness varies from 40′ to 60′, rather shaly and always showing more or less false bedding. A peculiar local coal bed occurs in it at some localities, known in this section as the "*Currie coal*" and in southern Butler as the "*Eichenhaur coal.*" It consists of two benches, part cannel and part bituminous coal, separated by a band of shale or sandy fire clay from a few inches to 2′ thick. (Plate 460.)

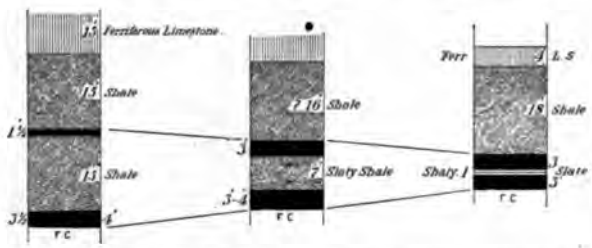
The *Kittanning group** contains its three coal beds much alike, persistent, about 3′ thick, of good quality and analyzing 43% to 55% fixed carbon, 36% to 41% volatile matter, 4% to 12% ash, 1% to 2½% water and 1% to 4% sulphur. (For coal bed sections see plate 460).

The *Kittanning upper coal C′* underlies the Freeport sandstone by from 5′ to 15′, and overlies the Ferriferous limestone from 110′ to 130′. This bed is the same as Mr. White's "*Darlington*" bed, and lies from 30′ to 35′ above the Kittanning middle bed. It is a good workable coal from 2′ to 4′ thick in parts of Worth, Brady, Slippery Rock

PLATE 458.

No XIII Allegheny River Coal Series in Butler Co.

Diagram showing the Clarion Coal split into two Beds



No XIII. Vertical Sections in Butler County.

Robert Allen Well Section.

Sandstone and shale to summit,		75′
[The Freeport Upper Coal and Limestone should appear near the top of this interval, but no trace of them was seen on the road.]		
Freeport Lower Coal blossom,	D	
Shale and Slate with S. S. near middle,		80′
Kittanning Upper Coal,	C′	3′
Sandy Shale,		42′
Kittanning Middle Coal, [Well mouth,]	C	3′
Well Record, . . Conductor,		17′
Fireclay?		15′
Shale,		8′
[Kitt., Lower,] . Coal,	B	10′
Fireclay,		2′
Loadstone,		2′
[Ferr. Limeat base,] White Sandstone,		40′
Shale,		10′
[Homewood S. S.] Black soft SS.		56′
[Mercer Group,] Shale,		48′
White soft S.S.		8′
[Mercer?] [?] Coal,		8′
Black S.S.,		36′
Mountain Sand,		152′
Shale,		20′
Black S.S.		10′
Gas and oil,		660′
S.S. heavy flow of salt water, to		1040′ 1090′
Depth of well,		1094′

Beaver River series, No. XII.



Parker Section.

Surface: place of Freeport Upper Limestone and Coal,		30′
Sandstone, thin bedded, fine grained, (Upper and Lower Freeport Sandstone,)		75′
Coal, worthless, "Currie Local Coal,"		1′ to 2′
Slate and slaty shale, olive and grey,		75′
Kittanning Middle Coal,	C	2′
Concealed,		34′
Kittanning Lower Coal,	B	2′ 6″ to 3′
Fireclay, 3′ to 6′,		5′
Concealed,		35′
Shale,		8′
Ferriferous Limestone,		15′
Dark shale,		30′
Clarion Coal,	A′	3′ 8″ to 4′
Concealed,		22′
Homewood Sandstone, "60 foot rock," massive,		15′
Shale and slate,		50′
Bituminous shale, sometimes impure (Mercer) coal,		3′
Sandy fireclay,		12′
Blue slate,		5′
Bituminous shale or impure coal, (Mercer Group,)		5′
Olive shale and blue slate with nodular ore near top,		47′
Shaly Sandstone,		20′
Blue and olive shale, with a band of bituminous shale and fireclay,		43′
Sandstone, thin bedded to creek level at Donnelly Station,		20′

Beaver River Series No. XII





very persistent, nearly always of good quality, and is of workable size in parts of Muddy Creek, Franklin, Worth, Brady, Clay, Slippery Rock, Cherry, Washington, Parker, Mercer and Venango twps.

The *Kittanning lower coal B* lies only about 40′ above the Ferriferous limestone and has its best development in Parker and Allegheny twps. Over the remainder of the district it is seldom of workable size. In Venango Co. it is a fair bed and at Brady's Bend it is quite valuable.

The *Clarion group* is again found to contain two coals as in Clarion Co. The *Scrubgrass bed*, or upper seam, immediately underlies the limestone, and has been detected in the northwestern part of the county, but too thin to be mined. Its usual thickness is from 6″ to 1′; but a short distance west from the county line in Lawrence a bank is opened upon it where it is 2′ thick. The *Clarion bed*, or lower member, is mined largely in the vicinity of Parker and Martinsburg. At the former place it is 4′ thick, but very sulphury coal. At Martinsburg it measures 7′ thick, with two benches of about 3′ each, with 1′ slate parting between. Going southward this slate in places almost entirely disappears; but northeast, toward Donnelly station, it rapidly swells to 7′, making the measurement of the whole bed about 14′. The upper bench is almost entirely lost before reaching Parker. On Slippery Rock and Wolf creeks the Clarion coal is rather thin and little worked. It is opened at a few banks in the northern tier of townships but is usually too thin or too slaty and sulphury to be a valuable bed. In Venango north of the Butler Co. line it has been opened and worked for many years. (Splitting of Clarion coal bed, see plate 458.)

The *Brookville coal* has also been mined at a few places in these northern townships. It varies from a few inches to 5′ in thickness, but is never a valuable bed owing to the many sulphur bands which it contains.

Southern Butler. The geological map of southern Butler contrasts strongly with that of the northern part of the county; for the gradual but steady sinking of the rocks

towards the southwest brings about a very much wider outspread of the *Barren Measures* group, so that the coals of the *Lower Productive Measures* are only exposed in the deep valleys of the Connoquenessing and Yellow creek along the Beaver Co. line and at the heads of various branches of the Allegheny river along the Armstrong Co. line. Suites of vertical sections of these rock groups and their included coal beds will be found in plate 457, giving a graphical representation of the variations they are subject to in this county.*

The Brady's Bend anticlinal passes through the southeastern corner of the county, just east of Saxon city and just west of Lardintown. In Clinton twp., near the head of Sarver's run, it brings the Upper Freeport coal to the surface, as it also does on Bull creek in the vicinity of Lardintown. The southeast slope of this axis is very sharp, showing near its crest dips of three degrees; but the northwest slope, whilst also rapid for a short distance, soon flattens, and the trough to the west is very shallow. The decline of the anticlinal axis to the southwest is very marked, falling approximately 550′ in 25 miles, or 22′ per mile in a direction of S 40° W.

The *Lower Productive Measures* retain many of their characteristics as shown in the surrounding counties,

*In the nomenclature used in this report, the old names for the beds of the *Lower Productive Coal Measures* were used, viz: Upper and Lower

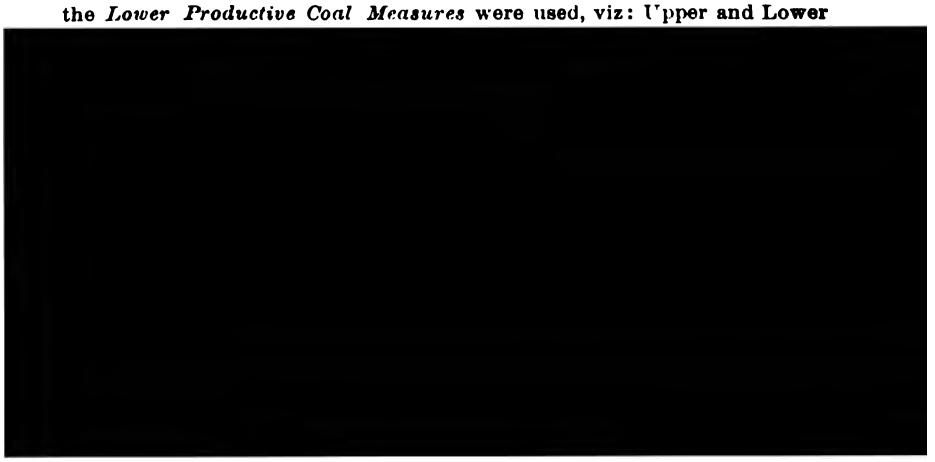
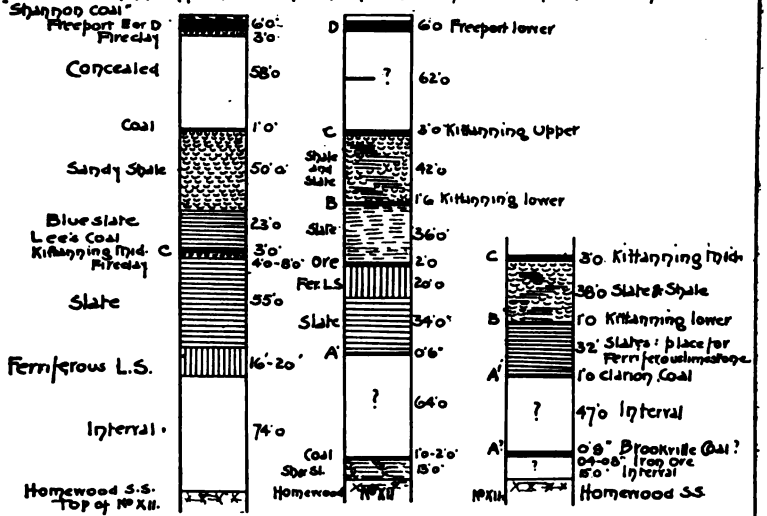
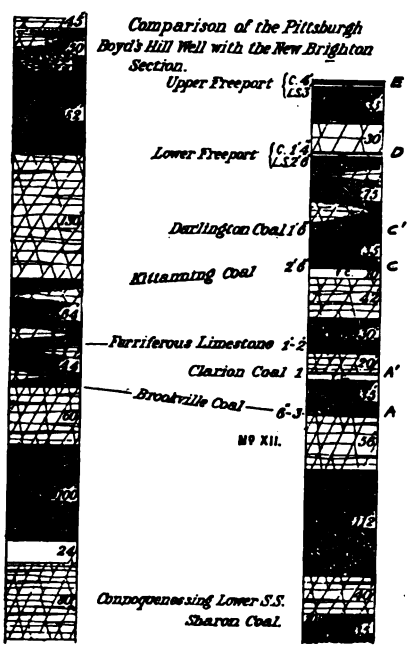


PLATE 459

No XIII. Allegheny River Coal Series in Butler County.

1. Wampum Section 2. Homewood Furnace 3. Clinton Section.





E.V.d.V.



although in many places the *Kittanning group* shows but two beds, the Lower Kittanning being frequently wanting, which fact gave rise to an opinion that the group normally contained but two beds instead of the three assigned to it elsewhere in the State. The confusion of identity was heightened by the fact that rarely if ever are the three beds found exposed at any one locality and the inference that the group was double was only natural.

The *Lower Productive coal series* outcrops along all the larger streams in southern Butler, and extends far up on the hills along all the streams of Beaver Co.; but neither the Pittsburg (Upper Productive Measures) or the Conglomerate series are exposed in the lower half of the county.

The *Upper Freeport Coal E*, (No. VI of the Ohio survey) was found to have a very irregular and erratic deposition within this district. In Butler it is of no economical importance over all the western half of the county, being rarely over 1′ to 2′ thick. It thickens up to 4′ in the neighborhood of Butler and is of workable dimensions over nearly all of the eastern half of the county, where its horizon is above drainage. At Lardintown it shows two main benches 3′ and 6″ thick separated by a 0½″ slate parting, and carries 1′ of slaty coal on top, or 4′ 6″ in all. As a general thing its fuel is quite sulphurous (Sections on plate 460).

The *Upper Freeport* (Butler) *sandstone* occupies the interval between the Upper Freeport limestone and Lower Freeport coal. This interval is usually sandy shale with thin layers of flaggy micaceous sandstone; but occasionally, as in the valleys around the town of Butler, these strata thicken up into a massive rock, here about 50′ thick. This however is not its general condition, so that the name "Butler" sandstone is only local.

The *Lower Freeport coal D** although exposed over a wide area in both Beaver and Butler Cos., and singularly

*It is the No. V coal of the Ohio reports and has been frequently called the *Middle Freeport coal* in reports H, H 2 and H 3, although the restoration of the old name of *Lower Freeport coal* is fully explained in other places.

persistent, is of almost no economical importance. At the mouth of Breakneck creek, on the Connoquenessing it becomes a workable bed 2½′ to 3′ thick of excellent quality, locally known as the "*Schantz*" coal.

The *Lower Freeport* (Butler) *limestone*, coming 3′ to 5′ below the coal, was also frequently mistaken by the First Survey both for the limestone which underlies the Upper Freeport coal as well as for the Johnstown cement bed beneath the Upper Kittanning or Darlington coal, and this error was perpetuated for some time in the early work of the Second Survey, naturally leading to much confusion in the nomenclature of the coal beds. In the eastern part of Butler Co. a valuable bed of carbonate iron ore rests immediately upon this stratum, and the old Winfield furnace on Rough run obtained its ore principally from this horizon. The limestone is seen at Butler in a cutting near the railroad depot, 2′ to 5′ thick. It is always non-fossiliferous.

The *Upper Kittanning* (Darlington) *coal C′*, the Ohio "*Strip Vein*" and No. IV (Lower Freeport (?) of Report H 3) is usually found at from 5′ to 20′ beneath the Freeport sandstone. On the Connoquenessing it appears above water level at about 7 miles above Harmony, and is constantly accessible and of workable thickness from that point down to the mouth of Slippery Rock. It is locally known as the "*Creek Vein*" in the vicinity of Harmony and shows a typical section of two benches of coal, 1′ 10″

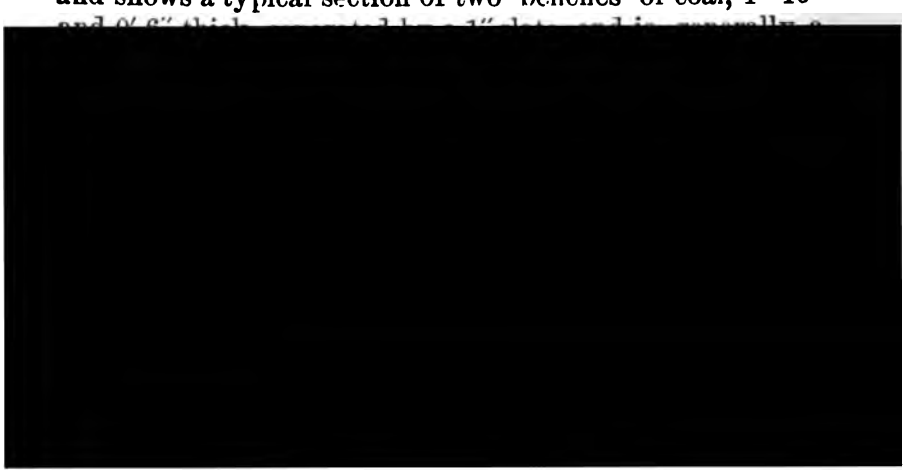
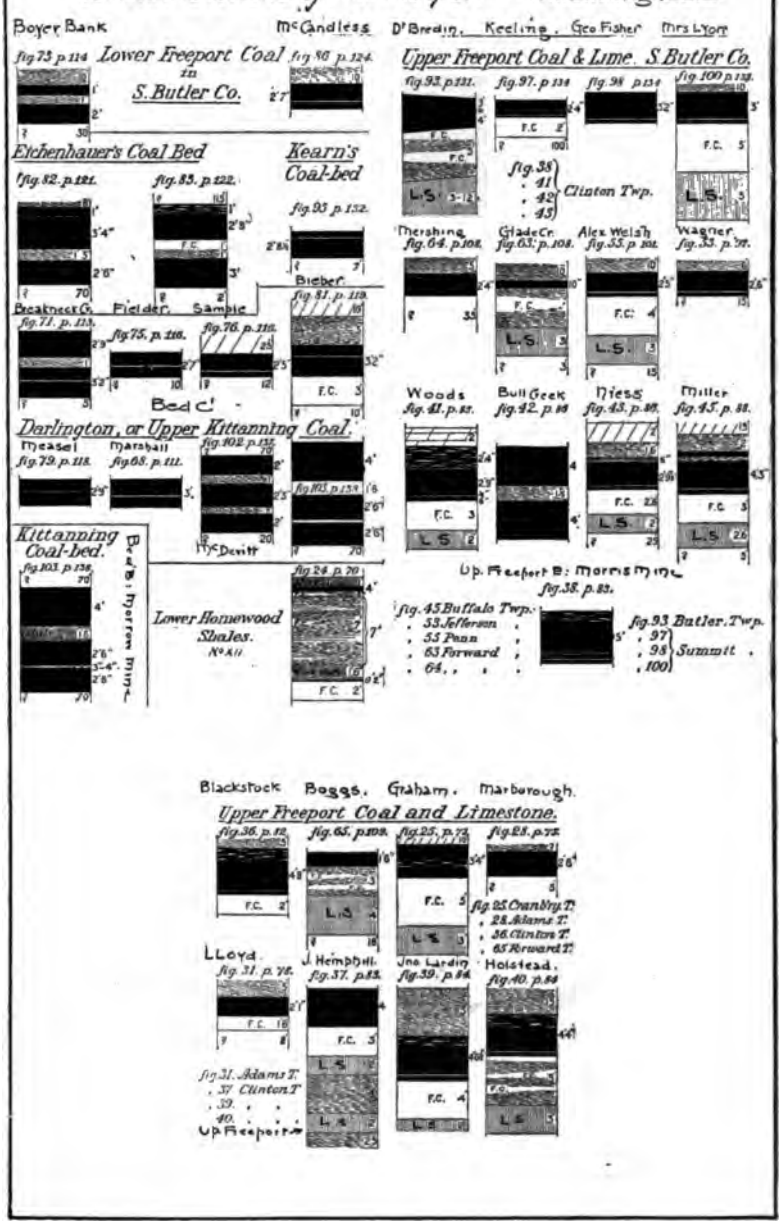


PLATE 460.

No XIII Allegheny Coal Series in Butler County. Pa Q

Vertical Sections of the Freeport and Kittanning Coals





is entirely persistent, though in a few instances it becomes too thin or too impure to work. It is brought to daylight by the Fifth Axis over a small area in eastern Butler Co., usually showing about 2′ thick. Also on the west branch of Big Buffalo creek in Clearfield twp. where it shows some singular variations and at one point, Deener's bank, a section of three benches of coal 2′ 0″, 2′ 0″ and 0′ 6″ thick, separated by an upper and lower shale parting 6″ and 1′ thick. The whole mass is about 8′ thick and the coal is mined by stripping, the bottom part being the best. It is just possible that the bed may have been mistaken for the Lower Kittanning coal. It was formerly mined on Rough run for the Winfield furnace. At Harmony, Mr. White estimates it to be about 40′ below the creek with an indicated thickness of 6′ in a bore hole; but it does not appear above water level on this stream in Butler Co.

The *Ferriferous limestone* is a very characteristic stratum in the series, but it is everywhere under water level in Butler Co., although showing 15′ thick over the arch of the Fifth Axis on Buffalo creek and 18′ on Rough run in Winfield twp. For this reason the underlying coal seams of the *Lower Productive measures* as well as the entire *Pottsville Conglomerate series* are nowhere exposed in the lower end of this county.

*No. XIII in Mercer County.**

Pending the preparation of the report on Mercer Co. there was still considerable uncertainty respecting the arrangement of the *Kittanning* and *Clarion coal groups;* but the work of the survey in adjoining districts and elsewhere in Pennsylvania has definitely determined the triple character of the first group, with the Upper Kittanning (Darlington) coal bed in the Allegheny River region always

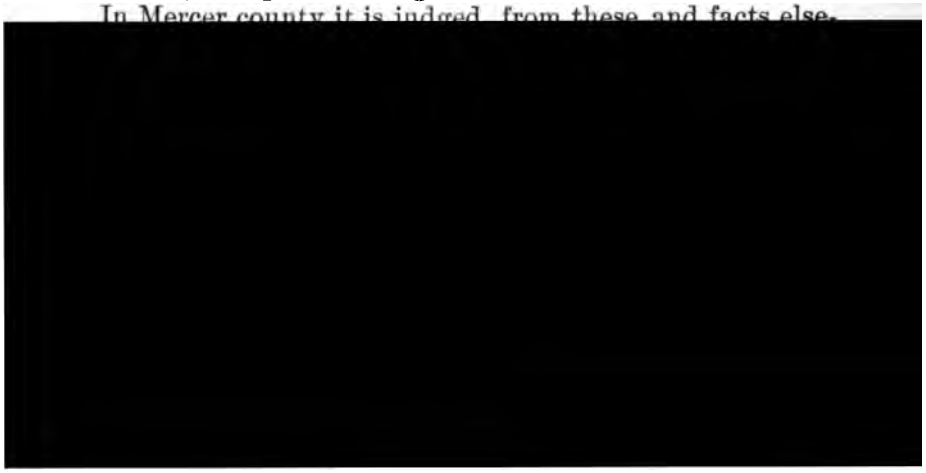
* Report Q 3 I. C. White 1880. Like Crawford Co. to the north, the coal measures of Mercer Co. are mainly confined to the *Conglomerate series*, the principal output coming from the *Sharon Block coal bed* which is responsible for the reputation this coal has received. Mention is made in report Q 3 of some 21 patches of the *Clarion coal bed* which have been preserved on the high divides in the eastern and southern townships, two of

lying from 110′ to 120′ above the Ferriferous limestone with the two lower Kittanning beds being variously absent from the section.

So too with the Clarion group. Mr. Chance clearly showed in his surveys of Butler, Clarion and Venango Cos. that the Clarion bed was frequently split into two members, to the upper of which he assigned the name of the "*Scrubgrass coal*," occurring from 0′ to 20′ beneath the Ferriferous sandstone, retaining the name "*Clarion coal*" for the lower bench, separated by from 20′ to 30′ from the Brookville coal bed at the bottom of the section overlying the Homewood sandstone, this latter bed being frequently absent.

Thus at Martinsburg the two benches of the Clarion bed form practically one seam of coal separated by from 5′ to 15′ of shales from the Homewood sandstone, with the Brookville coal absent. To the north and west of Martinsburg the Brookville coal is still wanting; but the Clarion bed is split into its two members. This is the state of things not only on Scrubgrass creek in Venango Co. but on Wolf creek on the western edge of Butler Co.; and in the central parts of northern Butler the top of the Homewood sandstone often lies 30′ to 40′ lower, allowing the Brookville coal (4′ to 6′ thick) to lie upon it, with an interval of from 25′ to 30′ up to the Clarion coal (2′ to 3′ thick) and 15′ to 25′ higher up the Scrubgrass coal.

In Mercer county it is indeed from these and facts else-

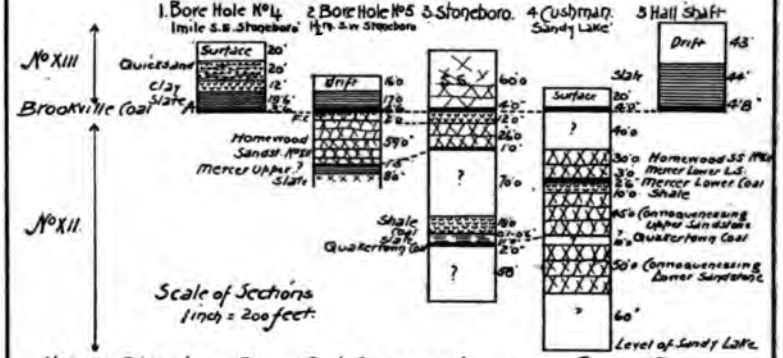


Mercer and Lawrence. PLATE 461

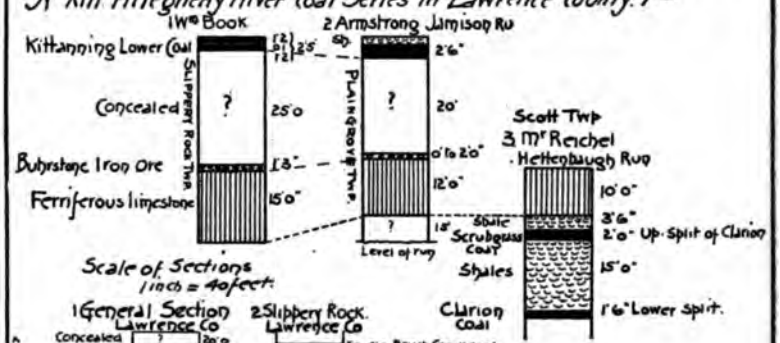
No XIII Allegheny River Coal Series in Mercer County.

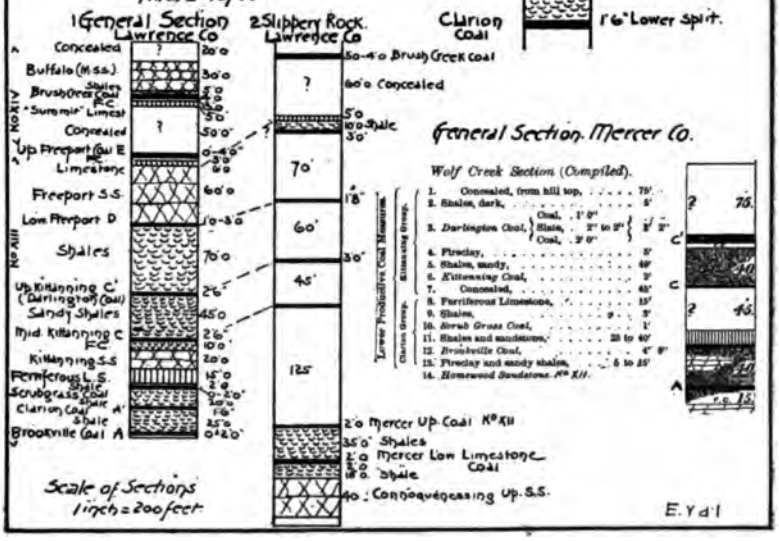
Vertical Sections in Lake Twp.

property Mercer Coal & Iron Co



No XIII Allegheny River Coal Series in Lawrence County, Pa.





General Section. Mercer Co.

Wolf Creek Section (Compiled).

1.	Concealed, from hill top,		75'
2.	Shales, dark,		5'
3.	*Darlington Coal,*	Coal, 1' 0"	8' 2"
		Shale, 2" to 2"	
		Coal, 3' 0"	
4.	Fireclay,		5'
5.	Shales, sandy,		40'
6.	*Kittanning Coal,*		2'
7.	Concealed,		45'
8.	Ferriferous Limestone,		15'
9.	Shales,		3'
10.	*Scrub Grass Coal,*		1'
11.	Shales and sandstone,		25 to 40'
12.	*Brookville Coal,*		4' 8"
13.	Fireclay and sandy shales,		5 to 15'
14.	*Homewood Sandstone. No XII.*		

Lower Productive Coal Measures. Kittanning Group. Clarion Group.

E. Y. d. l



the Sharon coal, seems to have been satisfactorily settled by the surveys in adjoining counties, which have placed this coal seam in the *Conglomerate series* and between the middle and lower members thereof and therefore necessarily *above* the Mountain Limestone members of the *Mauch Chunk red shale formation No. XI.*

Structurally the stratification of the rocks in Mercer Co. is very simple as there are no regular anticlinals or synclinals within its borders. Therefore the highest rocks in the geological series are on the ridges in the southern townships and going northward, toward Crawford Co. is equivalent to descending in the geological scale, as the entire rock series are gradually rising northeastwardly at a rate of about 20′ to 22′ per mile.

The *Lower Productive Coal Measures* (Kittanning and Clarion groups) occupy the highlands in the northeastern part of the county. A general vertical section compiled along Wolf creek exhibits all these measures that remain in this part of the county, and as given in plate 461, comprises 253′ 10″ between the top of the Homewood sandstone No. XII and about 80′ of shales on the hill top above Upper Kittanning (Darlington) coal. At Foster's bank, just south of North Liberty, this coal shows in good condition 3′ 2″ thick separated into two benches of 1′ and 2′ in thickness by a 2″ band of slate. In George's high knob half a mile east of North Liberty a shaft 25′ deep strikes the bed, parted as at Foster's, but very poor, slaty and pyritous. Total area 50 acres. It is possible however that this bed may not have been correctly identified as the Darlington coal, as its interval above the Ferriferous sandstone is less than 100′, thus bringing it within the horizon of the Middle Kittanning coal. A lower coal bed occurs from 45′ to 50′ below in a few high knobs in Liberty and one in Wolf Creek twp.; but it has never been mined to any extent, showing about 2′ thick.

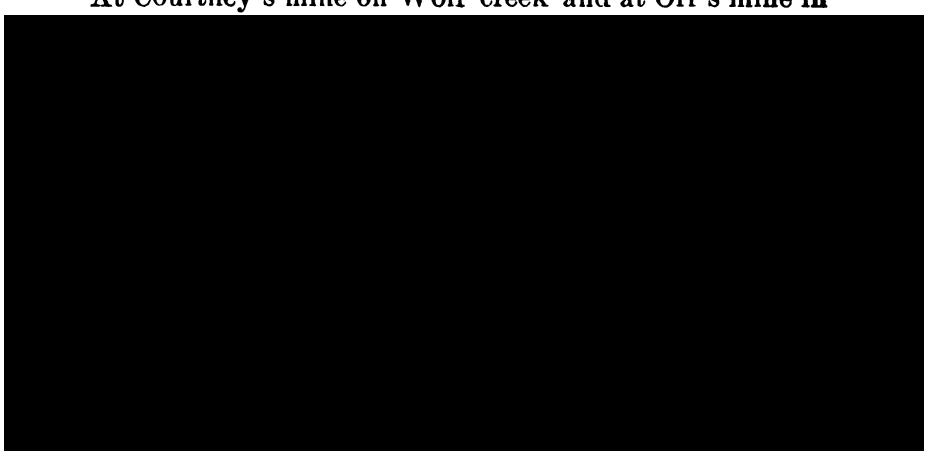
The *Ferriferous limestone* occurrence has already been referred to, and it exhibits about the same physical aspect as in Lawrence Co.; the upper part of a light ashen gray

color, glistening with calcite; the lower part 3′ to 4′ thick, of a dark blue color; both benches richly fossiliferous.

The *Scrubgrass coal* or *Upper Clarion* member varies little from 1′ in thickness, but is found underlying every exposure of the Ferriferous limestone in Mercer Co.; and is therefore often stripped for burning the lime.

The *Clarion coal bed* is stated to be wanting in Mercer Co. although the section given above as well the preliminary remarks in preface to that report indicate that the "*Brookville coal*" so-called, is none other than the *Clarion lower member* as reported in Venango and Butler Cos. Mr. White however states that the Clarion coal is plainly exposed on Hettenbaugh run in Scott twp., Lawrence Co., varying from 1′ to 2′ in thickness, and argues from that fact that there is no improbability in supposing that it thins out to nothing across the Mercer Co. line. (See plate 461.) Reasons have been adduced to show why the Brookville coal of the Mercer Co. report should be regarded as the Clarion bed of the district lying to the north and east from here. In any event this coal seam, lying from 25′ to 40′ beneath the Ferriferous limestone, is the most important and most widely extended coal bed in Mercer Co. being generally mined in Findley, Jackson and Lake twps., where it lies almost directly upon the Homewood sandstone, which fact undoubtedly gave rise to its being identified as the Brookville coal of Jefferson Co. (Plate 461.)

At Courtney's mine on Wolf creek and at Orr's mine in



The *Mercer Manufacturing and Mining Co.* mined from a large area of this coal in Findley twp., shipping as much as 400 tons daily, solely for steam and grate purposes, though the coal was sulphurous. The bed was found to thicken to 5′ and thin away to nothing in different places, and was much cut up by clay veins and horsebacks, rendering it expensive to mine. The *Jackson Coal Co.* had a similar experience in mining several hundred tons daily from their mines in Jackson twp., where the bed varied from 4′ in thickness down to almost nothing.

The *Mercer Iron & Coal Co.*, near Sandy Lick, have shipped 100,000 tons annually from this bed, here varying between 3½′ and 4½′, and though somewhat pyritous, making an excellent steam and stove coal. This coal was erroneously called the "*Tionesta*" bed by the *First Survey*, through mistaking the Clarion sandstone in the hill above it with the Homewood sandstone which underlies it.

In Lake twp. the same bed is mined on Lowry's land, 4′ 9″ thick, itself quite pure and highly esteemed by the blacksmiths, though parted by a sulphur band near the middle. In Sandy Lake twp. there is an area of this coal with no roof on it but the drift deposits, so that though the bed is fair in quality there are only about 6″ of bottom coal fit for smithing. In Worth twp., near Hendersonville the bed is good and 4′ thick; but the areas are small and isolated.

Other areas are found in the Lackawanna twps. and on Wrights land where the coal has been mined for many years for local use. The bottom bench only is fit for blacksmith use, the rest of the bed being too sulphurous.

*No. XIII in Lawrence County.**

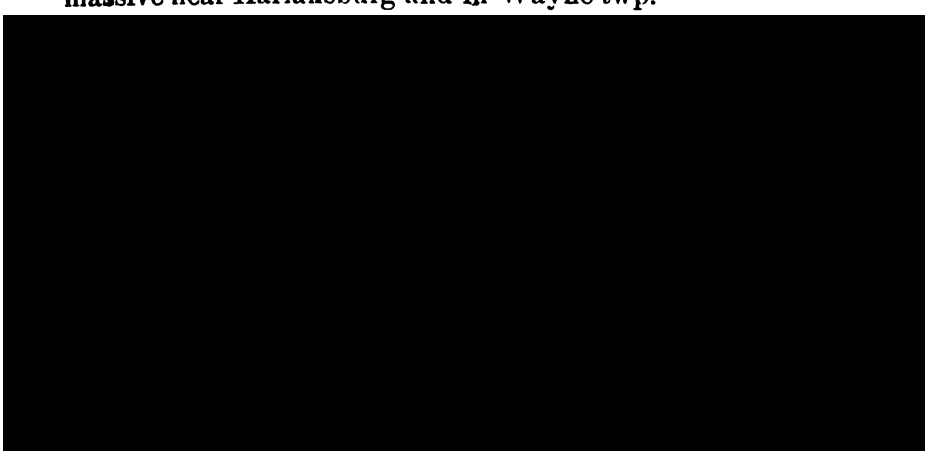
All the upland east of the Neshannock and east and west of the Beaver river is occupied by the Ferriferous limestone supporting the three Kittanning coal beds; and in Big

* Report Q 2. I. C. White, 1878. All the main valleys of the Mahoning and Shenango rivers and the Neshannock and Slippery Rock creeks have eroded channels through the *Lower Productive Coal Measures* into the

Beaver and Perry twps. the two Freeport coal beds and a little of the overlying *Barren Measures* also occur. The *Mahoning sandstone* is everywhere shaly in this county; but the coarse massive *Buffalo sandstone* member (30′ thick) caps the highest ridges of Perry twp. with bluffs and great blocks. Under it is the *Brush Creek coal* 4′ thick, with underclay 3′, and limestone sometimes 8′ thick.

The *Freeport upper coal* (70′ lower), locally known as the "*Five Foot*" and "*Four Foot*" bed, is over 6′ thick in several mines near the north line of Little Beaver twp., but thinner and poorer elsewhere; its underlying limestone seems generally wanting.

The *Darlington* (Upper Kittanning) *coal bed* varies from 2′ to 4′ and is exceptionally poor at the Beaver Valley mines; and in Slippery Rock valley it becomes sulphury. In the south-west corner of Plain Grove twp. it is a "block coal" (4′ thick), and was used raw in the old furnace on Taylor's run. Its most northern outlier is on a high knob on the Mercer Co. line in Washington twp. Eight analyses show from 38% to 41% volatile matter, 1.6% to 5% of ash, 1.6% to 3.0% of water and .5% to 2.5% of sulphur. The two other coal beds of the Kittanning series spread through the county and are locally mined, one of which overlies the famous clay deposit of Beaver Co., 10′ thick where mined a mile below Clinton, and the same thickness north of Croton. The underlying 30′ Kittanning sandstone is very massive near Harlansburg and in Wayne twp.



seems confined to Wayne, Shenango, Slippery Rock, Scott and Plain Grove townships, east of the Beaver river. At some mines there is only 1′ to 4′ of ore; at others it swells to over 20′, entirely replacing the limestone. The outcrops of the limestone proper range up and down all the valley sides of the eastern and southwestern parts of the county, its usual thickness being 15′, frequently swelling to 25′, but sometimes fading away to nothing, and divided into an upper and lower blue limestone, often with an intervening shale, both very fossiliferous. An average of the six ore specimens show: Metallic iron 50.849%, manganese .644%, sulphur .047%, phosphorus .214%.

The *Clarion upper coal* or "*Scrubgrass seam*" lies close under the limestone, but generally thin and of slight importance. A coal seam, 20″ thick and quite pure at Crawford's mine, Neshannock township, is occasionally found from 10′ to 15′ lower in the measures and the Clarion lower (Brookville?) coal, 2′ thick where mined above East Brook, occurs widely in the county.

A generalized section of the *Lower Productive group* of rocks in Lawrence Co. together with about 50′ of the bottom of the underlying *Barren Measure series*, is given in plate 461. It shows the group to have a total thickness of about 363′ and is only deficient in the exposition of the Kittanning series to which Mr. White has only assigned two coal beds instead of three. Hence in reading this report his *Darlington coal* must always be considered as the *Upper Kittanning bed* wherever this coal is described as being *approximately 120′* above the Ferriferous limestone. In like manner where this same interval is only about 80′ it should be regarded as representing the *Middle Kittanning coal;* and where only 40′ the *Lower Kittanning coal*, the difficulty of identification arising largely from the absence of one or more of these coal beds at any individual point in the county. The *Ferriferous limestone* is so magnificently developed, with great thickness and filled with peculiar fossil life, that it should form an unerring guide or key-rock to the coals above and below it.*

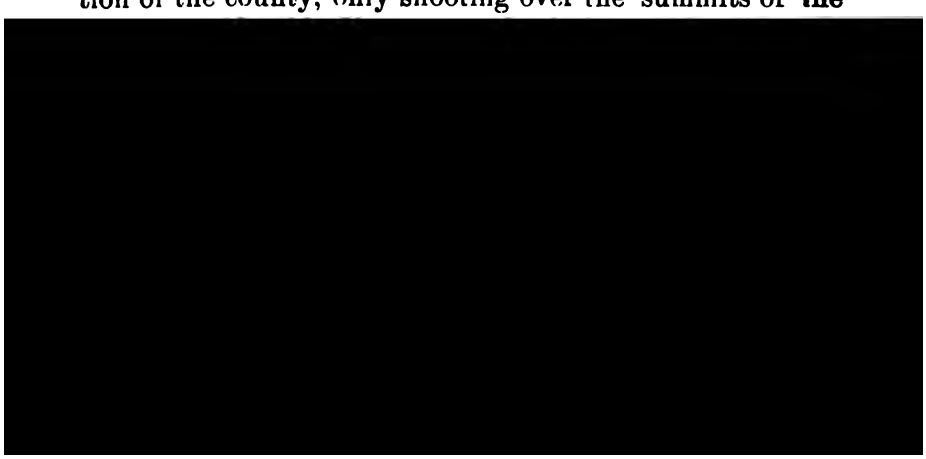
*The name of "*Tionesta*" is also frequently given to the now generally

The *Upper Freeport coal E* has a very small area in Lawrence county, seeming to show the same irregularity of distribution which characterizes it in Beaver county. It occurs from 130′ to 140′ above the Darlington coal and shows its best development in Big Beaver township, 1½ miles northwest from Wampum, where it has two 3′ benches divided by 2″ of slate. The coal is rather slaty and contains considerable pyrites, and its area is very limited.

The *Lower Freeport coal D* occurs from 65′ to 70′ lower and is more or less persisent, though confined almost exclusively to the southern tier of townships. West from the Big Beaver it has been frequently opened and extensively mined on the lands of Messrs. Mitchell, Robinson, Weatherspoon and others, where it shows a thickness of 6′. This coal is richly bituminous, has a bright black color and is highly prized by the smiths; but the area of its maximum development is quite limited and the coal rapidly deteriorates in all directions from the Mitchell tract. Its entire area in the county is too small to add much to the mineral wealth.

The Lower Freeport sandstone occupies the interval between the Lower Freeport coal and the Darlington bed and has but seldom been seen massive in Lawrence, being generally flaggy and laminated.

The *Darlington* (Upper Kittanning) *coal bed C* is the most important and persistent coal bed in the series. It comes low enough in the column to overspread a large portion of the county, only shooting over the summits of the



Along the Big Beaver valley it is exceptionally good and is largely mined for shipment to the iron mills as well as being excellently adapted for gas purposes. With greatest purity on Hog Hollow it deteriorates greatly in the Slippery Rock valley; but in the southwest corner of Plain Grove township the bed becomes 4′ thick, with its upper half a genuine block coal, and as such it has been used in the raw state for iron furnaces. North from Newcastle a considerable area is caught between the Shenango and Neshannock creeks; but it is there not so pure as in the Big Beaver valley.

The *Kittanning middle and lower coals C and B* are only recognized as one bed by Mr. White; and although detailed local surveys may have enabled a more exact differentiation of this part of the group, his report assigns but little commercial value to any coal bed exposed between the Darlington bed and Ferriferous limestone. In striking contrast to the variable and uncertain character of the coal is the bed of fire clay which underlies it; for its horizon is never exposed without finding it. Comparatively little use however has been made of this clay in Lawrence county although its presence is as strongly emphasized here as in Beaver county.

Reference has already been made to the wide occurrence of the *Buhrstone iron ore* and the *Ferriferous limestone** which separate the Kittanning and Clarion groups of coal.

The Clarion group is still found to be double in character, consisting of the upper member or *Scrubgrass coal* and the lower member or main *Clarion bed;* and Mr. White's section on Hettenbaugh run disclosed both these coals over-

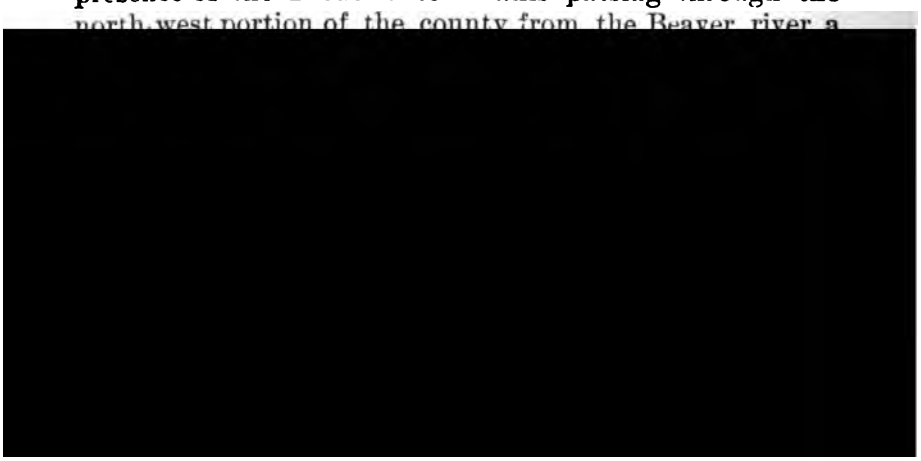
*In part II of report Q 2 Mr. White has written a special report on the "*Correlation of the Coal Measures in Western Pennsylvania and Eastern Ohio,*" which, for the first time clearly identified the Lowellville limestone of Ohio with the Ferriferous limestone of Pennsylvania, and brings about a harmony in the geology along the State line where formerly the utmost confusion existed, to the economic detriment of the adjoining coal fields. A series of 45 vertical sections constructed along Big and Little Beaver, Mahoning and Shenango rivers, are minutely described and give the strongest testimony for the accuracy of the nomenclature suggested by the Second Survey.

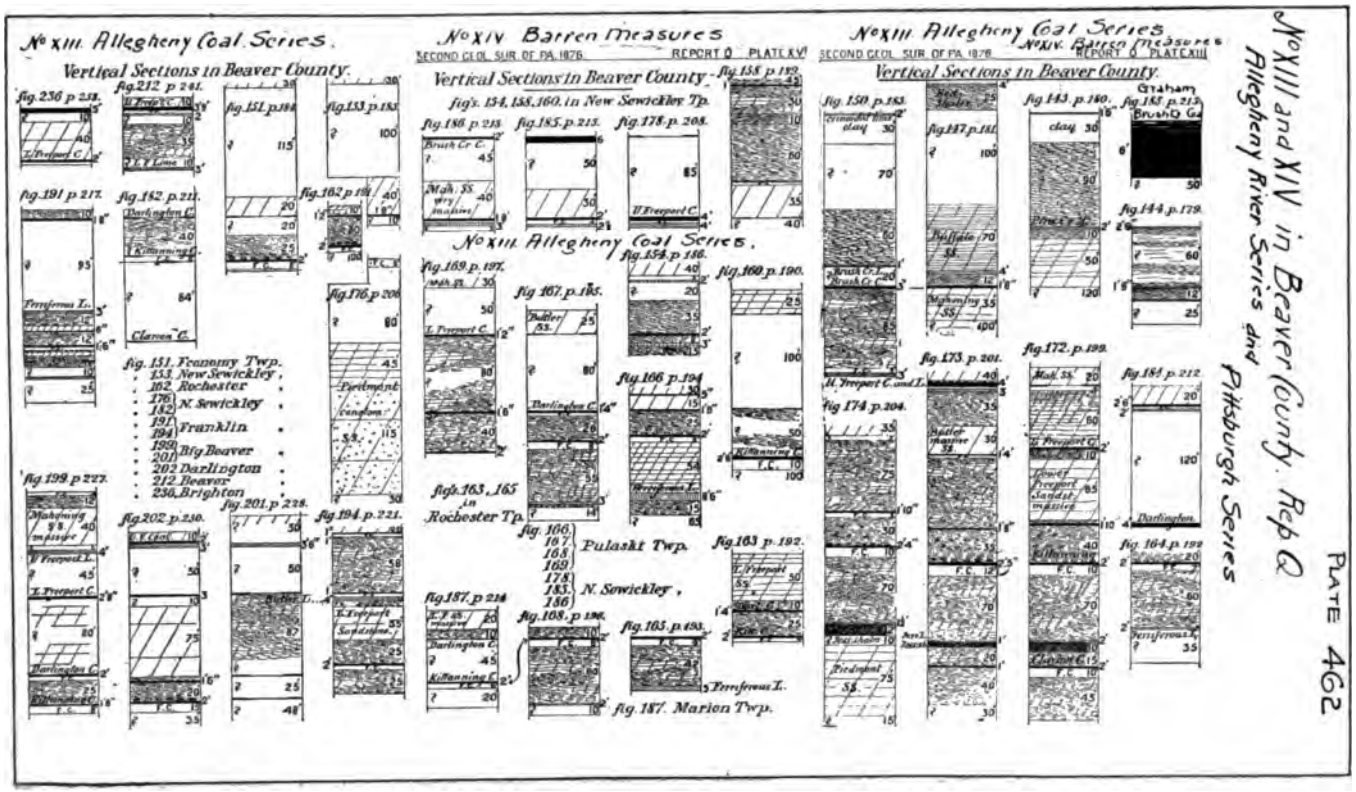
lying the Brookville bed. Both the Clarion beds are quite thin and have no commercial value; and the Brookville bed, always thin, is also frequently absent altogether.

No. XIII in Beaver County†.

The Ohio river makes a great sharp bend across this county, the Beaver river meeting it at the point of the bend, after cutting a long, straight gorge through nearly horizontal *Pottsville Conglomerate No. XII* massive sand rock strata, supporting an upland of *Lower Productive Coal Measures* of which the Freeport and Kittanning beds, the Ferriferous limestone, and the Clarion fire clay are the most valuable layers. All of the hill tops north of the Ohio river are capped with the *Barren Measures;* south of the river the country is made up of 600′ of Barren Measures with the *Pittsburgh coal bed* above them left in a few of the highest hill tops near the Washington Co. line. The continued sinking of the measures towards the south-west is entirely responsible for the great contrast of the surface geology here over that in Lawrence Co. directly north. The outcrop of the Ferriferous limestone is confined for that reason to the immediate valleys of the Ohio river and the Beaver river, extending from the Ohio line up to Freedom and up the Beaver into Lawrence Co.

The colored geological map of the county indicates the presence of the Fredericktown axis passing through the north-west portion of the county from the Beaver river a




No XIII Allegheny Coal Series.
Vertical Sections in Beaver County.
No XIV Barren Measures
SECOND GEOL SUR OF PA 1876 REPORT Q PLATE XV
Vertical Sections in Beaver County
fig's. 134, 158, 160, in New Sewickley Tp.
No XIII Allegheny Coal Series.
fig. 151 Franklin Twp.
153 New Sewickley,
182 Rochester
176 N. Sewickley
182
191
194 Franklin
198 Big Beaver
201 Darlington
212 Beaver
236 Brighton
figs. 163, 165 in Rochester Tp.
fig. 166 Pulaski Twp.
167
168
169
178
183 N. Sewickley,
186
fig. 187. Marion Twp.
No XIII Allegheny Coal Series
No XIV Barren Measures
SECOND GEOL SUR OF PA 1876 REPORT Q PLATE XIII
Vertical Sections in Beaver County.
Allegheny River Series and Pittsburgh Series
PLATE 462



base of the Barren Measures down to the Homewood (Piedmont) sandstone, the productive portion of the series in Beaver Co. may be said to end with the Ferriferous limestone. Typical sections show at Smith's Ferry, New Brighton and Kittanning. Other sections of both Nos. XIII and XIV are shown on plates 462 and 463.

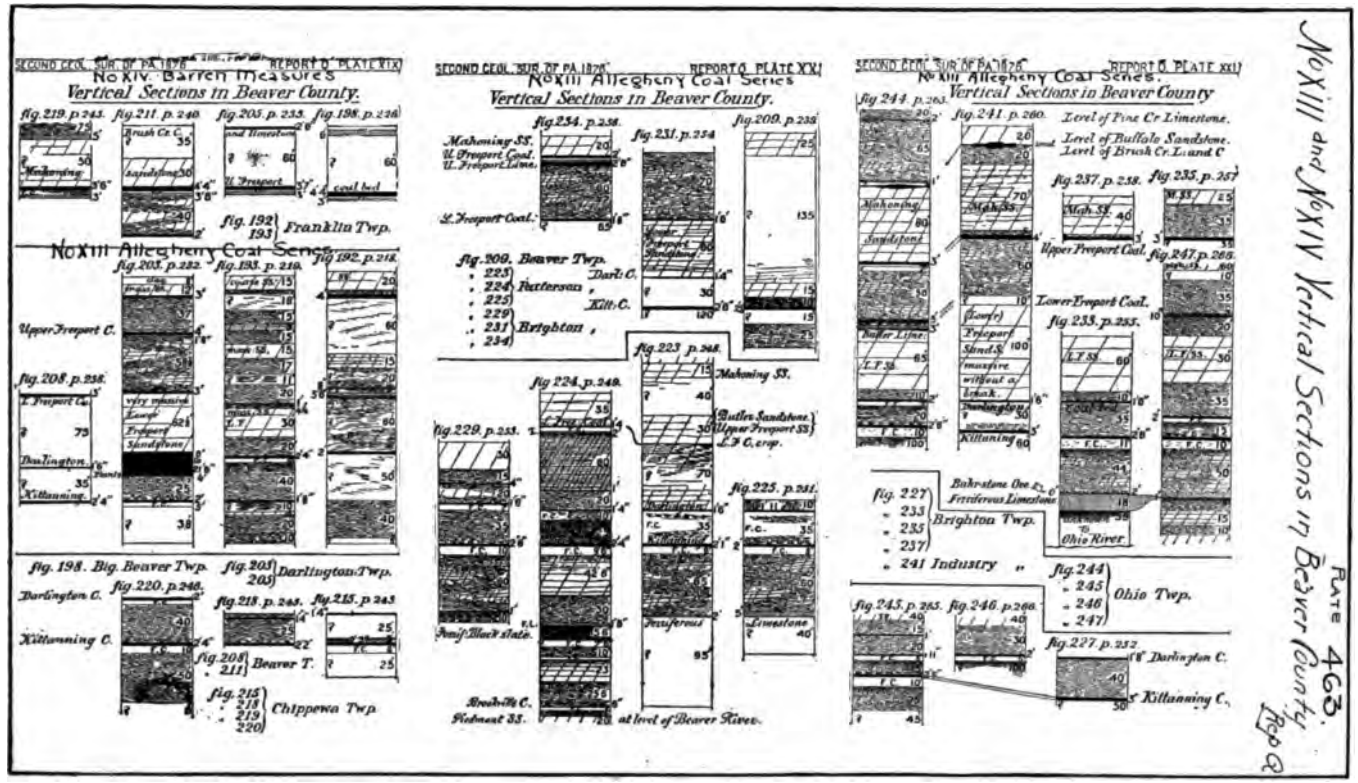
The *Upper Freeport coal E* (No. VI of the Ohio Survey) was found to be much more irregular and erratic in its deposition in Beaver county than elsewhere further east; for there are but two small areas where it is of workable size. Nevertheless it seldom thins away entirely and is nearly always found, when its horizon is exposed, from 0′ 6″ to 1′ 6″ thick. The structure of this coal when attaining its normal thickness of 4′, is nearly the same in every part of Beaver, Allegheny and Butler counties. Its variations and characteristics are graphically shown by a series of sections on plate 464. At the top there is usually 6″ to 8″ of impure slaty coal; then comes the main bench 2½′ to 3′ and always the best coal, below which comes a parting of slate or clay. The bottom coal is generally impure from pyritous slate. From the western part of Beaver county it has been extensively mined and shipped as a gas coal. In South Beaver township it has been opened on the Elder and Jackson farms with a total section of 4′ 6″, but showing four separate benches separated by thin slates. The bottom and top layers are impure and worthless; but the main bench, 3′ thick, is a fair coal and makes a good domestic fuel, though containing too much sulphur for smithing. At McMillan's opening, one mile south, the bed is 4′ 4″ thick with the same slaty top and bottom layers. The working bench is 3′ 1″ thick, carrying a small binder 3 inches from the bottom; but the coal contains rather more sulphur than usual. One-half mile south from Brush run the bed shows a similar character as mined by Mr. Hartford, 4 feet thick; while 1½ miles further south, where opened by Mr. Moore and Mr. McDade, it shows but two benches, an upper 3′ 0″ and a lower 0′ 6″ divided by 3″ of slate. The lower coal is impure and the upper only fair.

In Ohio township the coal is again exposed on the high hill above Smith's Ferry and has a thickness of about 3′ in three benches; upper 2′ 0″, middle 0′ 3″ and lower 0′ 8″ with two thin bands of slate between the benches, 0½″ and 1″ thick. The coal has been gouged out of the hill from time to time, and the bed well exposed, though it has never been regularly mined. It contains much sulphur and has no commercial value.

The *Lower Freeport coal D* was also found to be of little economic importance, attaining workable dimensions at only a few localities, although exposed over a wide area in both Beaver and Butler counties. It is geologically singularly persistent however, either as a small coal bed or a richly bituminous shale. In the vicinity of Baden it attains a thickness of 2½ feet over a small area and has been mined there for a number of years. It is a rather poor coal however, being slaty and impure. On Trough run, opposite Beaver Falls, this coal is seeu at one point 4 feet thick, in a bed of impure cannel. In the western part of the county it has been mined in a few instances though of no importance in thickness or quality.

The *Lower Freeport limestone*, occurring so closely beneath this coal, forms a ready means for ascertaining a geological horizon, although similar in character and size to that which underlies the Upper Freeport coal. It is however more ferruginous and earthy, and less compact than the higher stratum.





No XIII and No XIV Vertical Sections in Beaver County.

PLATE 463.

Rep Q



which becomes the more natural on account of the variable condition of the bed, its geological horizon and in Beaver county.

In Darlington township, whence it takes its local name, the coal becomes a great bed of cannel, although it is a mere local deposit and has never been found off the Mansfield tract in this township. Immediately underneath the coal at this point there occurs a dark sandy shale, crowded with plant remains.* The coal is usually separated in three distinct benches; a lower 6″ to 1′ of bituminous coal; a middle bench of cannel from 6′ to 12′ thick, gradually passing into the third bench on top, a mass of cannel shale, which is sometimes 6′ in thickness. The bituminous coal is very pitchy and its layers laminated with streaks of cannel. At the upper mine, where the cannel has thinned away, the bituminous bench becomes 2½′ to 3′ thick and has been extensively mined and shipped as gas coal under the name of the "*Beaver Block Coal.*" The cannel coal is always of fair quality though containing a large percentage of ash. It however makes a good gas coal and averages about 7 feet thick, graduating imperceptibly into the cannel shale above. The whole bed exhibits the most remarkable variations. Around the margins of the deposit the sandstone roof frequently comes down to meet the bottom shales and cut out the coal entirely, varying from 0′ to 6′ in 50′.

That this is a very abnormal development of the Kittanning upper coal is amply proven by a large number of openings on this bed in other parts of the county; for although often quite thin it appears to be an almost universally persistent and accessible bed north of the Ohio river. Its usual horizon is from 5′ to 20′ below the Freeport sandstone, although that massive rock frequently rests upon it, of course adversely affecting the coal.

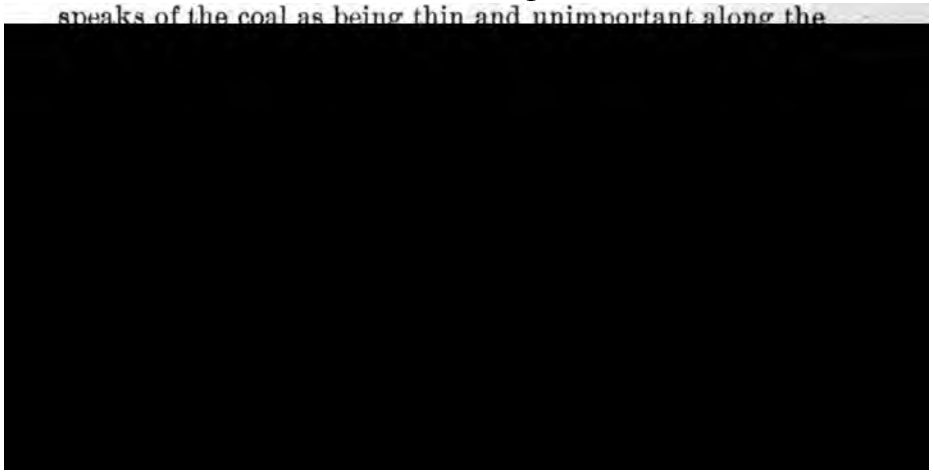
On the Big Beaver it has been extensively mined between Clinton and Homewood, and shipped as gas coal. It here shows an upper coal bench 2′ 5″ and a lower bench 4″, sepa-

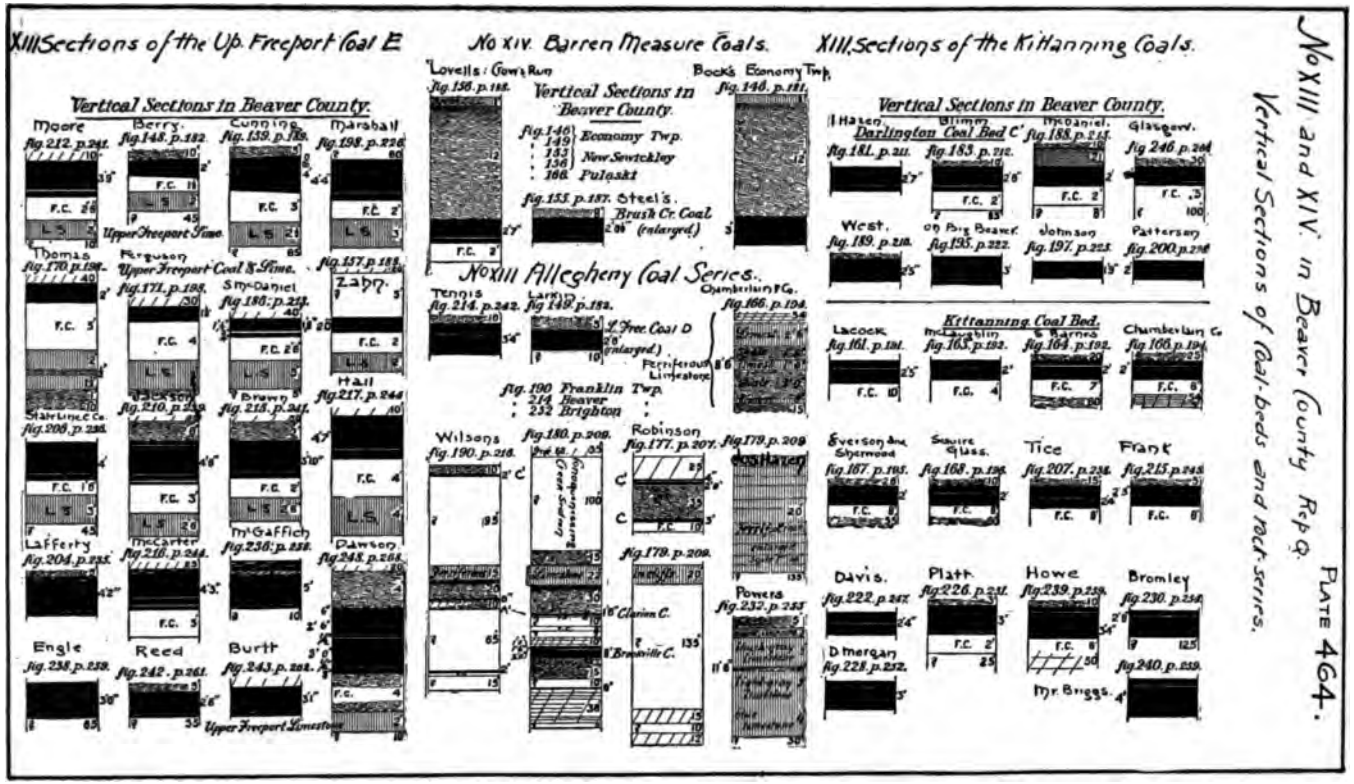
*See Report Q, pages 54 and 55.

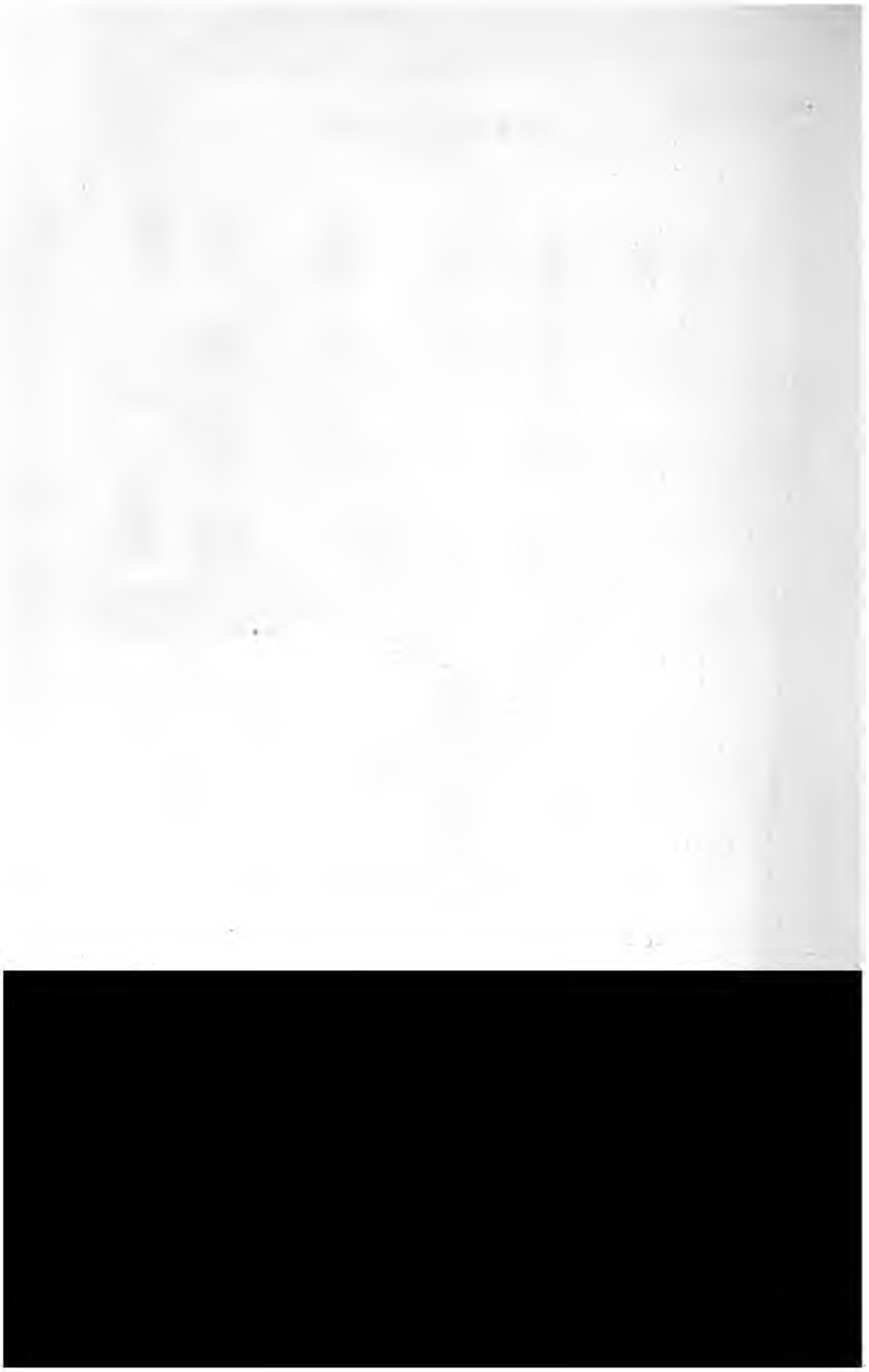
rated by 1″ to 1½″ of slate; though thin it is here a splendid coal and very rich in volatile combustible matter. Before reaching Homewood the bed thins away to only 18″ and continues thin to Bennett's run, 3½ miles above New Brighton, when it again thickens up to 3′ and furnishes a coal of very general excellence. (See sections 464.)

Passing down the Beaver it soon thins away again, and although remarkably pure it is no longer of workable thickness along the stream, seldom more and frequently less than 16″. This fact has given it the local name of the "18 inch" or "blacksmith vein," since it is preferred by the smiths to all other coal. Along the Ohio it is constantly present but never workable except in the neighborhood of Smith's ferry where it thickens up to 2′ with a thin band of slate 3″ above the floor, the top bench being exceedingly pure but the bottom sulphurous.

Beneath the Darlington bed other coals frequently outcrop at intervals of about 35′ and 70′ lower in the measures; and though it is pretty well understood now that these intervals represent the middle and lower Kittanning coals, either of which may be locally absent, Mr. White (in report Q) calls them both the *Kittanning coal C*, judging the beds to be the same but the intervals to vary greatly. At all events the bed is rarely of merchantable thickness or quality and very little mining has been carried on within this interval of 70′ below the Darlington coal. Mr. White speaks of the coal as being thin and unimportant along the




No XIII and XIV. in Beaver County Rep Q.
Vertical Sections of Coal-beds and Rock-strata.
PLATE 464.
No XIII Sections of the Up. Freeport Coal &
Vertical Sections in Beaver County.
Moore
Fig. 212. p. 241.
Berry.
Fig. 148. p. 182.
Cunning.
Fig. 139. p. 178.
Marshall
Fig. 198. p. 226.
Upper Freeport Lime.
Thomas
Fig. 170. p. 198.
Ferguson
Upper Freeport Coal & Lime.
Fig. 171. p. 198.
Sm. McDaniel
Fig. 180. p. 213.
Zahn.
Fig. 157. p. 188.
State Line C. Co.
Fig. 208. p. 238.
Jackson
Fig. 210. p. 239.
Brown
Fig. 218. p. 241.
Hall
Fig. 217. p. 244.
Lafferty
Fig. 204. p. 235.
McCarter
Fig. 218. p. 244.
McGaffich
Fig. 236. p. 252.
Dawson
Fig. 245. p. 268.
Engle
Fig. 238. p. 259.
Reed
Fig. 242. p. 261.
Burtt
Fig. 243. p. 262.
Upper Freeport Limestone
No XIV. Barren Measure Coals.
Lovells: Cow's Run
Fig. 156. p. 188.
Vertical Sections in Beaver County.
Fig. 146 } Economy Twp.
: 149 }
: 153 } New Sewickley
: 156 }
: 166 } Pulaski
Fig. 155. p. 187. Steel's.
Brush Cr. Coal
2'0" (enlarged.)
Bock's Economy Twp.
Fig. 146. p. 181.
No XIII Allegheny Coal Series.
Tennis
Fig. 214. p. 242.
Larkin
Fig. 149. p. 182.
Upper Free. Coal D
2'0" (enlarged.)
Ferriferous Limestone
Chamberlain & Co.
Fig. 166. p. 194.
Fig. 190 Franklin Twp.
: 214 Beaver
: 232 Brighton
Wilsons
Fig. 190. p. 216.
Fig. 180. p. 209.
Robinson
Fig. 177. p. 207.
Fig. 179. p. 209
Fig. 179. p. 209.
Clarion C.
Brookville C.
Powers
Fig. 232. p. 253
Ross Hazen
XIII. Sections of the Kittanning Coals.
Vertical Sections in Beaver County.
I. Hazen
Darlington Coal Bed C'
Fig. 181. p. 211.
Stimer
Fig. 183. p. 212.
McDaniel.
Fig. 188. p. 215.
Glasgow.
Fig. 246. p. 268
West.
Fig. 189. p. 218.
on Big Beaver
Fig. 195. p. 222.
Johnson
Fig. 197. p. 223.
Patterson
Fig. 200. p. 226
Kittanning Coal Bed.
Lacock.
Fig. 161. p. 191.
McLaughlin
Fig. 165. p. 192.
& Barnes
Fig. 164. p. 192.
Chamberlain Co.
Fig. 166. p. 194.
Everson & Sherwood
Fig. 187. p. 195.
Squire Glass.
Fig. 168. p. 196.
Tice
Fig. 207. p. 238.
Frank
Fig. 215. p. 245.
Davis.
Fig. 222. p. 247.
Platt
Fig. 226. p. 251.
Howe
Fig. 239. p. 259.
Bromley
Fig. 230. p. 254.
D. Morgan
Fig. 228. p. 252.
Mr. Briggs.
Fig. 240. p. 259.



found underlying the Kittanning coal, as noted by Mr. White, though it is generally inferred, on the testimony of interval, that this clay bed underlies the Lower Kittanning bed, 60′ to 80′ lower than the Darlington coal. This clay bed has given rise to an important industry in the making of fire brick, furnace lining, terra cotta ware, etc. At Bridgewater a large amount of fire brick has been made for the furnaces of the Mahoning and Shenango valleys. The clay is seldom less than 10′ and sometimes 15′ thick; but usually not more than from 6′ to 7′ is used, as the bottom becomes too siliceous. It is believed to be identical with the bed of clay so extensively worked along the Ohio river in Ohio.

The *Ferriferous limestone* is again the most characteristic stratum in the series It is the largest, purest and most massive limestone and always possesses a peculiarity of composition and organic remains which assist in distinguishing it.

Near the mouth of Brush creek on the Connoquenessing it is only 1′ to 2′ thick; but it soon begins to increase in size westward and in three miles below its point of first appearance it makes huge cliffs along the stream, 20′ to 25′ thick. It maintains this unusual development to the mouth of the creek, and thence down the Big Beaver to the old Homewood furnace it carries a thickness of 15′, soon rapidly thinning away to a feather edge on top of the Homewood sandstone so splendidly developed at Homewood station. Persistent as a bed 1′ to 2′ thick it can be followed down to New Brighton, where as three members divided by beds of shale it carries a thickness of 8′. Along the Ohio it becomes thicker and more massive until at Vanport, 3 miles below the mouth of Big Beaver, it is magnificently opened at Tygart's quarry 18′ thick, carrying only 1′ of shale between its two upper gray limestone benches, 7′ and 5′ thick, with blue limestone at the bottom 5′ thick. At Allen's quarry, near Industry it is 15′ thick; but passing down the river it becomes gradually sandy and earthy, leaving a layer of limestone on top only 6″ thick.

Near the Ohio line at the mouth of Little Beaver it is 1′ thick and 60′ below the "Kittanning coal:" this bed therefor should undoubtedly be regarded as the Middle Kittanning coal.

The *Scrubgrass coal* or *Upper Clarion bed* seemed to have no representation in Beaver Co. The Clarion coal proper is likewise without commercial representation, although present as a bed 1½′ thick on the Connoquenessing, and seldom more than 1′ thick along the Big Beaver, where it is nearly always found at 20′ to 30′ below the Ferriferous limestone. Here it rests upon a large bed of fire clay 7′ to 10′ thick, the lower part non-plastic.

The *Brookville coal* is frequently seen along the Big Beaver, resting with its underlying fire clay immediately upon the Homewood (Piedmont) sandstone, about 30′ to 50′ beneath the Clarion coal.

Above Beaver Falls it shows a worthless bed of two benches, 1′ 2″ and 0′ 7″ separated by 3′ of shale. It was once mined at the mouth of Brady's run, below New Brighton, where it was 3′ thick; but the opening has been long abandoned and the coal was reported to be quite slaty. Both this coal and the Clarion bed thin away along the Ohio river, so that in the Smith's Ferry section they are represented by bituminous shale.



coal; 1′ bituminous shale; 3′ 6″ coal; 3″ clay and 6″ of coal. Near the mouth of Service creek on Raccoon it is 11′ 6″, with however only 6″ of top coal and 1′ of bottom coal to represent the fuel portion of the bed. The Freeport limestone is quite persistent, but the Lower Freeport coal is identified with difficulty and never more than 10″ thick.

The Freeport sandstone is micaceous but compact and never less than 75′ thick. The Kittanning coal rises from the river 1½ miles above Freedom, and southward becomes so bad as to be known as the "Sulphur vein." It is 3′ thick at mouth of Raccoon; 2′ 1″ at Philipsburg and Georgetown. Beneath it is an important bed of fireclay, which is manufactured into fire brick at Philipsburg, and the Ferriferous limestone, though largely concealed, is well exposed 2½ miles below Raccoon creek, where it is 12′ thick. Down the river it thins and becomes impure and consists of only 1′ of impure limestone, with a cone-in-cone structure, whereas on Allen's property it is a compact rock, wonderfully rich in fossils and yields an excellent lime.

The various analyses of coal, cannel, coke, clay, limestone and ore from Butler and Beaver Cos. will be found at the end of report Q, pages 275 to 283.

*No. XIII in Allegheny County.**

The *Lower Productive Measures* have a comparatively limited outspread in this county, confined almost entirely to the district bordering on the Allegheny river around Tarentum and to a limited area over the Brady's Bend axis.

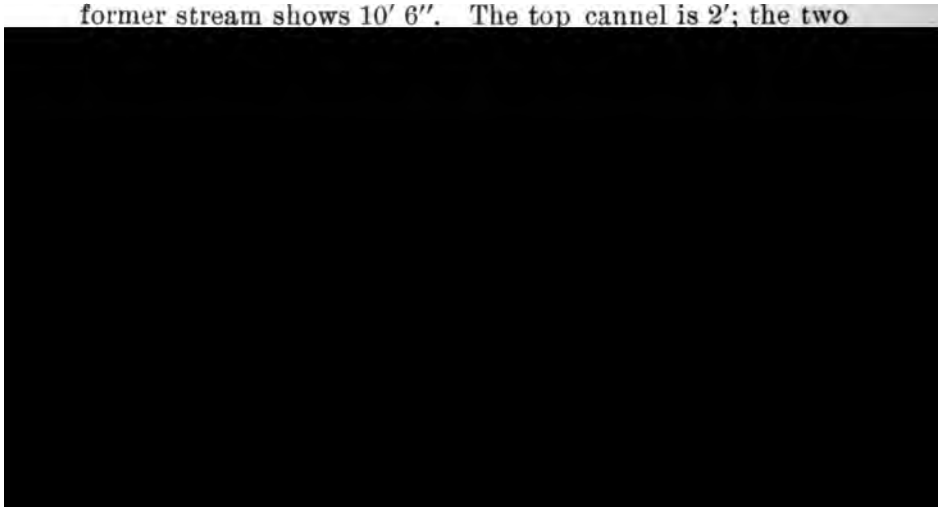
In Fawn twp., 2 miles below Burke's mill, the Freeport upper coal shows 3′ 8″ thick, of which the top 6″ is shaly and the balance contains 1″ of slate 3″above floor; Burtner farm. The coal is fair, but somewhat pyritous. After passing beneath water it again appears at the Methodist Camp meeting ground 3′ 6″ thick, with same divisions; separated by 15′ from its limestone 7′ thick, with three bands of lime-

*Included in Prof. I. C. White's report Q, on North Allegheny. For illustrations see plates 462 and 463.

stone 2′, 2′, and 1′ 5″ and two bands of shale 1′ 3″ and 3″ thick. It is extensively mined by Mr. Pugh, but contains considerable sulphur. Passing up Bull creek the coal is frequently seen, and on Bandy's land a section shows the bed 4′; the limestone 12′ lower and 5′ thick and the Freeport lower coal D 1′ 6″ still 45′ lower. Mr. Woodrow mines the upper coal higher up on McDowell's run 4′ 9″ thick, the top 11″ slaty and the main coal carrying two thin binders. It is also mined by Messrs. Kennedy, Summons, Hill and others and finally by Mr. McDowell 4′ 2″ thick with its two binders and 6″ of slaty top coal, separated by 3′ of clay from its limestone 2′ thick.

In East Deer twp. next south along the river the Freeport upper coal shows below Robertson's run at Bailie Bros. salt works, where the Ferriferous limestone 12′ thick was struck in a well 272′ below bed E. A section of bed shows 9′ 6″ thick, carrying 2′ of top cannel; coal 2′ 9″; slate and bony coal 0′ 8″; coal 2′ 10″ and two small binders in bottom 1′ 4″ coal. The coal is good and rich in bituminous matter. At Hitestown the bed is 10′ thick the two upper main benches being 3′ thick, separated by 7″ of bone and slate and bottom bench 1′ 3″ with two thin binders. This great development of bed E commences ½ a mile above Hitestown, above which place the bed is only 4′ thick.

In West Deer twp. it is elevated by the Fifth axis on Bull creek and Big Deer, and at Mr. Brewer's on the former stream shows 10′ 6″. The top cannel is 2′; the two



Shaw's mill the coal is 7′ 6″ thick; a top bench 3′; slate and coal 1′, coal 3′, slate 0½″ and bottom coal 6″. The upper bench is fair; the lower bench much better. On Miller's land 1 mile above Shaw's it is 4′ 8″; but again only its lowest division is workable and good. Further north the bed thins away rapidly, being 3′ thick at Huber's. The limestone is hard, compact and contains considerable iron.

At Sharpsburg the Freeeport upper coal is from 80′ to 100′ below the river; but ascending Pine creek the measures rise rapidly on to the Brady's Bend axis, exposing bed E along the P. & W. R. R. from above Glenshaw to Bryant station in Hampton. At Glenshaw the coal has been mined by a shallow shaft largely to coal engines. Quite an area of good thick coal was found at the bottom of the shaft, some of it 10′ thick with partings; but in every direction the coal was displaced by a sand fault so that entries have been run for long distances in rock without yielding any coal whatever. The coal itself is similar in character to Deer creek and Hitestown. Further north in Hampton twp. the bed thins out almost to nothing. The axis crosses near the head of Gourdhead run at Mrs. Meyer's, where the Lower Freeport bed D is just lifted above creek level, 2′ thick, and 35′ below bed E. In Harmer twp. bed E is shafted upon under the Verona axis on the river and careful levels prove its interval below the *Pittsburgh coal* to be 660′.

In all southern and western Allegheny, as well as in Washington and Greene Cos., the *Lower Productive measures* are entirely buried from sight.

CHAPTER CXXV.

No. XIV. The Barren Measures or Pittsburgh Series.*

The *Barren Measures* or *Pittsburgh Series No. XIV* is a name assigned to a group of rocks not far from 600′ thick†, separating the *Lower* and *Upper Productive Coal Series*, and limited by the horizons of the Upper Freeport coal below and the great Pittsburg coal above‡; some observers preferring however to throw the Mahoning sandstone at its base into the top of the Lower Productive Series.

The group is broadly divisible into two very different members; an *upper*, composed largely of shaly red beds and thin sandstones, creating by erosion a pleasing, rounded topography; and a *lower*, largely massive sandstones, making rugged scenery and deeply marked topography.

The coal beds are noted for their variability and general worthlessness in Pennsylvania; and any economic value

*These rocks are called by Prof. White the "*Elk River Series*" in West Virginia, where they contain several important and persistent coal beds; but in Pennsylvania the entire group is wanting in merchantable coal.



in the series is attached to the great sandstone (building) deposits. The few limestone beds are thin and sporadic and like the coals, are of meagre value. The group is especially well exposed along the Monongahela river above and below Pittsburgh and on some of its main tributaries southward towards West Virginia; but the series is widespread, outcropping in whole or in part through many of the separate basins eastward to the Allegheny Mt., especially south of the West Branch of the Susquehanna river.

The principal coal beds are named from above downwards: *Little Pittsburgh*, *Elk Lick*, *Bakerstown*, *Masontown* and *Gallitzin*, with several others of less importance and outspread.

The *Little Pittsburgh coal* is more persistent in Pennsylvania than further south. It seldom exceeds 2′; in few places swelling up to 4′ in thickness. Sometimes a couple of thin limestone beds occur beneath it through the interval of shales down to the first conspicuous (*Connellsville*) sandstone deposit. The latter is frequently conglomerate, and was named from its typical exposure on the Youghiogheny river. Its top averages 40′ to 60′ beneath the Pittsburgh coal and it varies from 25′ to 50′ in thickness, sometimes shale or flags.

The second great (*Morgantown*) sandstone is an especially prominent horizon, occurring about 200′ below the Pittsburgh coal and 25′ thick. It is the "first oil rock" of the Dunkard Creek region along the West Virginia line and some wells in it have yielded largely; but in Washington county, where it is from 500′ to 1000′ beneath the surface, and from 35′ to 50′ thick, it generally contains salt water.

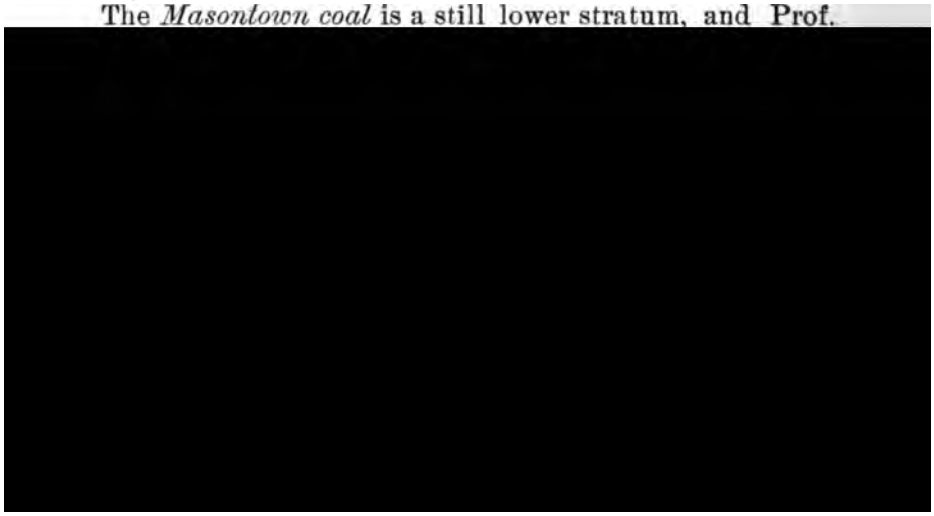
The *Elk Lick coal* immediately underlies this sandstone, and is one of the few fairly persistent coals of the series. Still its character is very variable and thousands of dollars have been sunk in vain attempts to explore its attractive surface appearance under ground. It has been mined in past years in Somerset county, 4 feet thick, where it was closely studied by the Messrs. Platt and its proper geological horizon first correctly fixed. In Westmoreland,

Fayette and Allegheny it seldom exceeds 2′. Its limestone also attains prominence only in Somerset county, where at a short interval below the coal it shows12′ thick.

The *Crinoidal* or *Green Fossiliferous limestone*, midway in the group, is a very important horizon marking (as Prof. White states, Bulletin 65, U. S. Geological Survey, page 90) "a change from fresh or brackish water deposits to marine conditions." Dr. Stevenson first demonstrated its usefulness as an horizon to measure from, being nearly equi-distant all through western Pennsylvania from the Pittsburgh and Freeport coals; and being so strongly characterized with abundant evidence of *Brachiopods* and *Lamellibranchs*, it can readily be recognized in a series of rocks so different lithologically from it. A coal beneath it, usually very thin, swells to 7′ in the *Berlin basin* of Somerset county, where it is called the "*Platt bed;*" but it is very impure, filled with slaty layers, and not persistent.

The *Bakerstown coal* is another locally prominent seam, found from 75′ to 90′ beneath the Crinoidal limestone in Allegheny county; 3′ thick and slaty, and possibly representing the *Price coal bed* of Somerset county, also locally valuable, and 4′ thick. The *Coleman* and *Philson coals* are also found here, beneath the Price bed, but rarely noticed elsewhere in the State, and sometimes accompanied by limestones which Prof. White identifies as the Cambridge limestones of Ohio.

The *Masontown coal* is a still lower stratum, and Prof.



Barren Measure rocks in Pennsylvania; but the individual county maps constructed by the Survey all delineate their occurrence. In a general way their northern limit may be placed in Clearfield, Jefferson, Armstrong and Butler counties. Small patches of their lowest (Mahoning sandstone) member are still preserved in isolated spots in Centre, Clarion and Elk counties; but they have been totally swept away from all northern Pennsylvania, where indeed it has already been shown that frequently the still lower *Allegheny River Coal Series No. XIII* is only retained in the highest hills. In the southwestern corner of the State, in Greene and Washington counties and the long narrow basins containing the gas and coking coals of Westmoreland and Fayette, they are largely buried beneath the Pittsburgh coal and higher measures; and they are also partially hidden in the *Salisbury basin* of Somerset. But elsewhere they form the surface rocks through a very large district of the State; always variable, always persistent, and always broadly devoid of mineral wealth. East of the Alleghenies they are totally wanting except in the *Broad Top Coal Basin* of Huntingdon and Bedford counties.

In this field the highest beds of the series are retained in the *Dudley basin;* but they are poorly exposed, except a massive sandstone, coming in 75′ above the *Dudley coal*, a slaty bed which occurs a few feet above the top of the Upper Mahoning sandstone, and 100′ to 125′ above the Kelley (Upper Freeport?) coal E. Various vertical sections of these *Barren Measures* in this field are shown in connection with the underlying coal series in plates 396 to 402. The general section already given in the early pages of this report shows 520′ of the Barren Measures exposed at Round Knob; but this is far more than is usual for the district.

The *Mahoning sandstone* is the chief rock of the series.* It is the "Top Rock" of the miners, preserving the coal

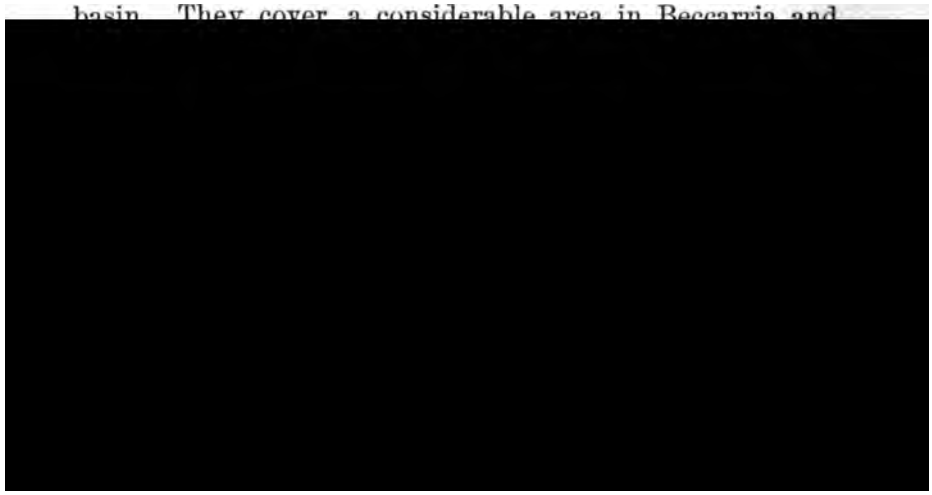
* As exhibited in Huntingdon Co., it consists of two members; an upper buffish-gray, rather massive sandstone, seldom pebbly, sometimes flaggy or even shaly, 50′ to 60′ thick; and a lower, very massive gray rock, often a mass of white pebbles, 25′ to 30′ thick.

from erosion. But in Bedford the upper member is also massive and sometimes a distinct conglomerate. Between these two members there frequently occurs a generally worthless coal bed, 1½′ to 3′ thick, locally known as the *Spear bed* and the equivalent of the Gallitzin coal of Cambria. It is called the "*Twin seam*," from the fact that it is often double, carrying a thick clay parting. It thins away northward and is absent in Huntingdon Co. On Big Sandy, below the mouth of Long run, in Bedford Co., it occurs in pockets, 1′ to 10′ thick, and though severely crushed and broken into lenticular fragments, it is of good quality and much used for domestic purposes.

In Centre Co. in the few patches left in the heart of the First and Second basins, the *Barren Measures* (Mahoning sandstone member) show argillaceous slates and shales and occasionally a gritty sandstone—so imperfect in the section that the *Gallitzin coal*, usually occurring 55′ to 60′ above the Freeport upper bed E, was nowhere identified and the whole Mahoning sandstone mass has greatly deteriorated.

In Clearfield Co. these rocks are found only in a few districts, the vignette map (plate 409) clearly showing their outspread and relationship to the underlying coal and conglomerate series, Nos. XIII and XII.

The *Barren Measures* are found capping the highest summits along Bloomington ridge south of Curwensville and Clearfield, and also in the trough of the Ansonville sub-basin. They cover a considerable area in Beccaria and



sandstone. Only one important coal bed occurs in this district, its horizon doubtful, but either the *Gallitzin* or *Philson* bed. It is commonly from 2′ to 2½′ thick, but along Muddy creek reaches and even exceeds 3′, thus becoming a valuable bed. It yields an excellent hard and black coal.

In the *Third Basin* the Barren Measures are spread out over parts of Brady, Sandy and Huston twps. In many parts of this county, especially in the First basin, the *Mahoning sandstone* on top of the coal measures strongly resembles the *Homewood sandstone* (top of No. XII) at their base.

They impress upon the surface of the county the same topographical features and both are often quite coarse andpebbly

The failure to distinguish between them in the early years of the Survey led to the greatest errors in delineating the productive coal areas, as the two sand rocks are really 300′ to 400′ apart. The *Barren Measures* occur mainly in the highest lands in the deeper portions of the *First* and *Third* basins, and aggregate about 200′. In the *Houtzdale-Philipsburg* basin the Mahoning sandstone is a pebbly rock or conglomerate along the Amesville ridge on the south, northeast of Coal run; but coming east towards the centre of the basin it loses its conglomerate nature and becomes a fine or coarse-grained whitish sandstone; sometimes shaly or fri able, and sometimes entirely replaced by slate and shale.

The *Gallitzin coal* has been worked in the neighborhood of Utahville, near the Cambria Co. line, from 2′ to 3′ thick.

In the southwest corner of the county in Burnside twp. (Third Basin) the Mahoning sandstone is a massive conglomerate capping the hill summits east of Cherry Tree, 300′ to 350′ above the river.

The various vertical sections of the Lower Productive group No. XIII in Clearfield (on plates 412 and 413) show the presence of, character, and thickness of this Mahoning sandstone and overlying Barren Measure rocks.

No. XIV in Cambria County.

In this county the *Barren Measures* fill nearly the whole of the First and Second and part of the Third basins. The Allegheny Mountain and the Laurel Hill uplifts have laid bare complete sections of the underlying coal measures, which have been likewise eroded and exposed along the branches of Clearfield creek and the Susquehanna in the northern end, and along Black Lick and the Conemaugh in the center and south ends. But throughout the vast areas over which the *Barren Measures* spread as surface rocks they are totally devoid of workable coal beds, and contain only one or two thin limestones to give them any value whatever.* Nevertheless recent borings through these measures along the Pennsylvania R. R. would certainly seem to indicate their increased thickness (up to 1000′) as that interval occurs between the highest hill summits (devoid of the Pittsburgh coal) and the underlying Freeport coal E.

The *Mahoning sandstone* in the trough of the First basin seems to be largely replaced by shale; but it becomes more massive west of the *Viaduct axis*, and has been extensively quarried for ballast and building purposes along the Penna. R. R. west of Summerhill. In the Cresson shaft 300′ of these measures have been cut,† showing the *Gallitzin coal* 1′ 0″ thick, 110′ above bed E, the intervening lower Mahoning being largely hard gray sandstone, with beds of fire

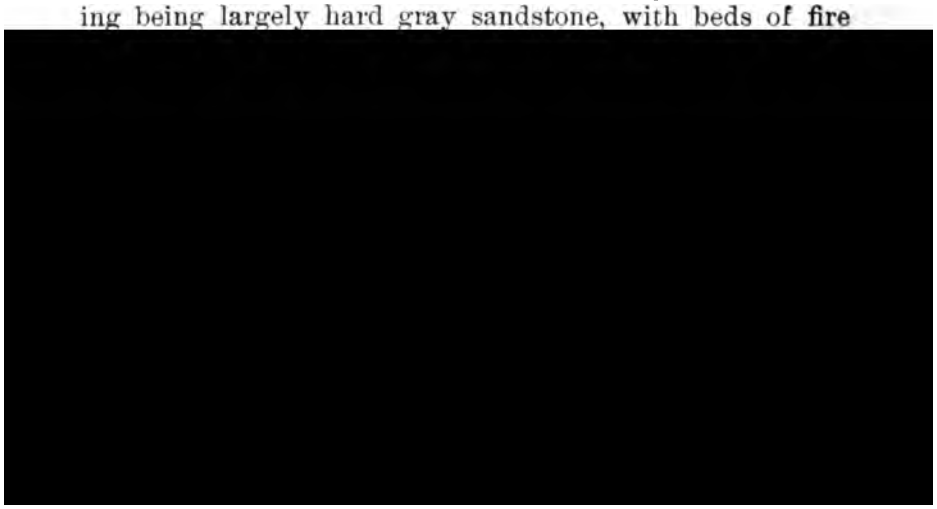
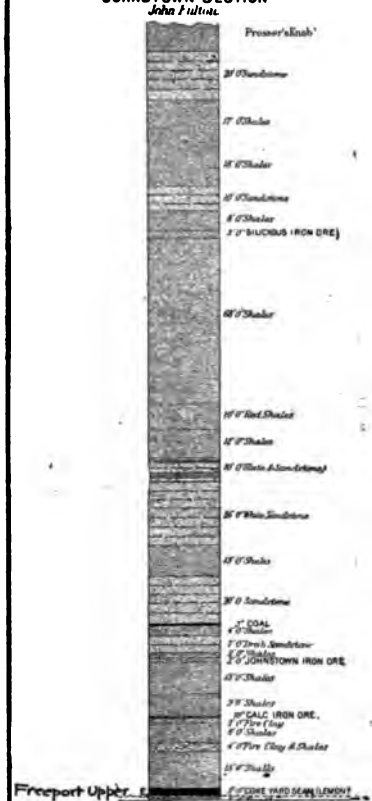


PLATE 465.

No XIV Barren Measures or Pittsburg Series in Cambria Co.

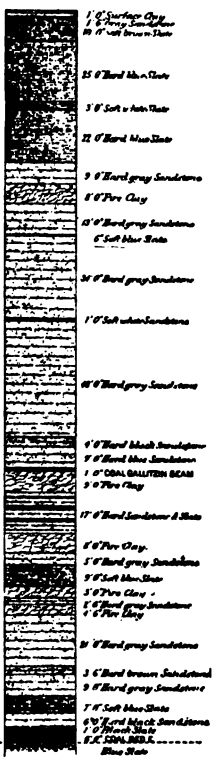
Second Basin

JOHNSTOWN SECTION
John Fulton

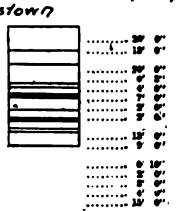


First Basin

CRESSON SHAFT
1 MILE EAST OF CRESSON ON THE PENNSYLVANIA RAILROAD
Cresson Coal & Coke Co



Mahoning Sandstone Ore Group
Johnstown



White thin bedded sandstone	20'	0"
Shales, drab colored	12'	0"
Massive drab sandstone forming cliff	20'	0"
Coal	2'	2"
Shale, drab colored	2'	0"
Drab sandstone	7'	0"
Shales	2'	0"
Johnstown iron ore	2'	0"
Black and drab colored Shales	12'	0"
Iron stained shales	2'	0"
Calcareous iron ore not yet worked	0'	10"
Fire clay	2'	0"
Soft, drab shales	2'	0"
Fire clay shales	4'	0"
Sandstone, massive	10'	0"



blue, black and gray sandstone, two of them 34′ and 48′ thick. Above these the measures are largely slate. Other sections of these rocks, so far as exposed, in the Carrolltown and St. Boniface district; at Johnstown and along Penna. R. R. may be seen on plates 465 and 466.

The whole series in this county contains little of interest in the *First basin* which is all the more strange in the light of the splendid development of this group in Somerset Co. immediately adjoining on the south; but in the *Second* or *Johnstown basin* importance was formerly attached to this group by reason of their containing certain beds of iron ore, no longer mined in the presence of the rich Lake ores, but significant as being one of the principal reasons for the location of the great Cambria Iron Works, which company sought this uninviting location largely because of the close relationship of these ores to the underlying coal beds of the Lower Productive Series. The Mahoning sandstone here is a tripple formation, separated by large masses of shales, within which these ores occured as carbonate iron ore or iron stone.* The following section shows the character of the Mahoning sandstone group (plate 465):

White thin bedded sandstone,	26′	0″
Shales, drab colored,	13′	0″
Massive drab sandstone forming cliff,	20′	0′
Coal,	0′	3″
Shale, drab colored,	4′	0″
Drab sandstone,	7′	0″
Slates,	2′	0′
Johnstown iron ore,	2′	0″
Flesh and drab colored shales,	13′	0″
Iron stained shales,	9′	0″
Calcareous iron ore, not worked,	0′	10′
Fire clay,	2′	0″
Soft, drab shales,	8′	0″
Fire clay shales,	4′	0″
Sandstone, massive,	15′	0″

The ore band yields, on an average, 30% to 35% of metallic iron. It is found only in the centre of the basin, mainly

*These same ores formed in part the stock for the large iron industry at Fairchance in Fayette Co., where they were formerly mixed with the "*Pittsburgh ores*" obtained higher in the Barren Measures, beneath the Pittsburgh coal bed, to be presently described.

along the north bank of the Conemaugh, its eastern outcrop at Conemaugh station, high in the hills, from whence it descends westward nearly to water level at Hinckston's run, only to rise again on the flank of Laurel hill. Its position and relationship to the underlying *Allegheny River coal series* at Johnstown is well shown in cross-section on plate 466.

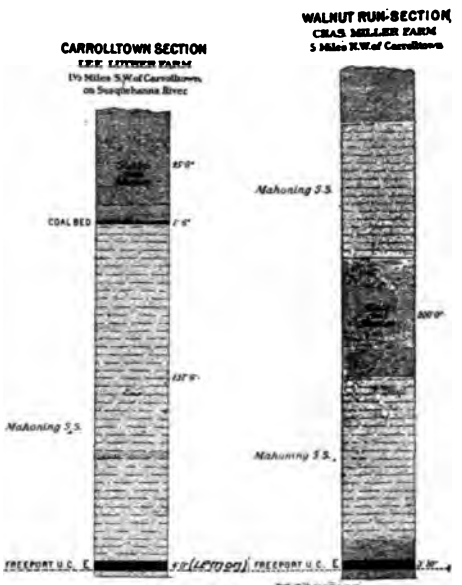
The ore bed varies little from 52′ above bed E. It also occurs south on Mill creek where it was once extensively stripped, and at the old Cambria furnace at the base of Laurel hill. There is also a band of siliceous iron ore 180′ higher in the series. The bed worked at Johnstown is divided into two bands by fire clay shale, 1″ to 1′ thick. The upper bench is richer than the lower, the latter being calciferous; and both bands contain sufficient lime to be self-fluxing. The ore was calcined before being put into the furnace. The bed is underlaid by slate and oxidizes rapidly at the outcrop, changing from dove color to a reddish brown. Local rolls and squeezes abound in the mine openings, the ore averaging about 2′ thick. The Mill creek deposit is very regular, but contains rather less iron and more silica.

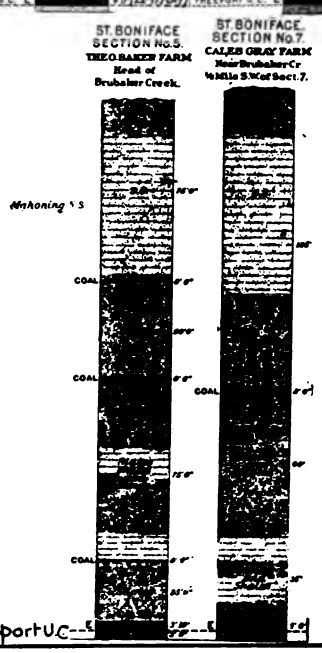
The *Barren Measures* in this *Second basin* occur much more abundantly north of the Conemaugh, reaching far up the flank of the Laurel Hill axis. Around Ebensburg they spread over into the *First basin*, whilst in north Cambria they arch over the axis itself in Susquehanna twp., and

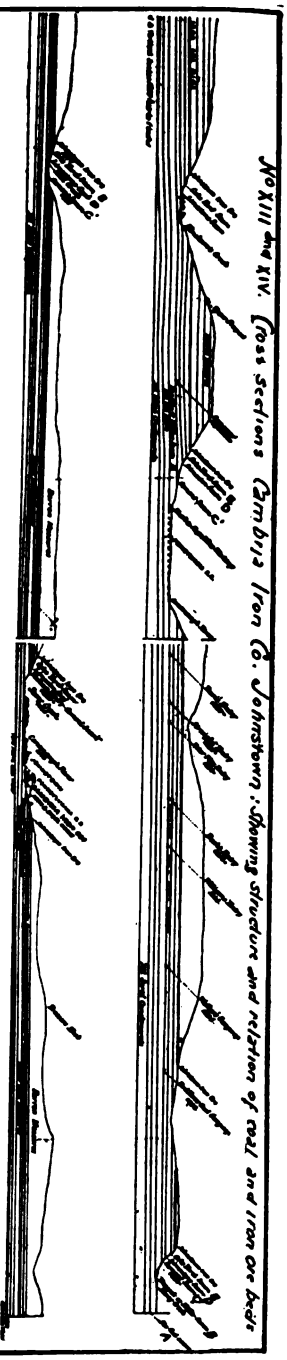
PLATE 466

No XIV Barren Measures in Cambria Co

in the Second and Third Basins.







No XIII and XIV. Cross sections Cambria Iron Co. Johnstown: showing structure and relation of coal and iron ore beds



much promise of value; and a vertical section of this group will be found in plate 421 and plate 467.

The *Wellersburg coal bed*, or top seam of the series, lies about 430′ beneath the Pittsburgh bed, corresponding in geological position to the *Berlin bed* of the Salisbury basin, and has been mined for local use in two benches, 2½′ and 2′ thick, separated by a blue slate from 6″ to 2½′ thick. The second bed lies 50′ lower and would correspond in position with the *Coleman bed* at Berlin; but the latter seam has a 3′ limestone under it, while this Wellersburg coal has a 2′ limestone for a roof. The third coal bed lies 144′ beneath the Wellersburg bed, reported 3′ thick, and has been provisionally compared with the *Philson bed* of Berlin, which however lies only about 100′ beneath the Price, and has moreover a well defined limestone under it which does not exist here. The fourth coal bed lies about 95′ lower, 2′ 4″ thick, with a limestone floor, with nothing to correspond with it as a coal bed at Berlin. It is not likely that these Barren Measure coals will have a market value for a long time to come, and as both the coal beds and the limestones which accompany them are so notoriously liable to the greatest variation, we are in no condition for determining their identity with parallel beds in the adjoining basin west.

In the *Salisbury basin* the Barren Measures have a wide outspread between the two groups of Productive coals; but they are only imperfectly exposed. (Section on plate 467).

The *Price coal bed*, 2′ thick, 160′ below the Elk Lick limestone and 385′ below the Pittsburgh coal, can be readily identified along the railroad, with the same characteristics it shows on Blue Lick. The *Elk Lick limestone*, 225′ below the Pittsburgh coal, is regular and persistent through this part of the field, generally showing two layers, in all about 6′ thick, separated by a thin shale parting, the upper bench containing the best stone.

The *Elk Lick coal* is usually a 4′ bed of excellent quality, and occurs about 350′ above the Mahoning sandstone.

The *Little Pittsburgh coal and limestone*,* the latter averaging 4′ to 5′, but the overlying coal apparently valueless, are both found at many points in this basin.

The influence of the geology upon the agriculture of Somerset Co. can be stated in a very few words. The almost undisturbed flatness of the coal measures produce both smooth and high plateaus, gently rolling glades, and steep, rocky, sterile and wooded hillsides several hundred feet in height.

The massive limestones of the Upper Coal Series occur only along *Salisbury ridge;* but they make a fertile soil on the spot, and furnish abundance of lime for exportation. Most of the county is a rolling country of Barren Measures, with hillsides of gentle slope, covered with a deep, though rather lean soil, easily improved by fertilizers. The abundance of sandstone (Morgantown, &c.) above the Elk Lick coal bed makes the hill slopes of the Salisbury ridge.

The shales and numerous thin limestones between the Elk Lick coal and the Mahoning sandstone produce soft hill slopes and wide, low valleys, with a deep soil, very productive where the limestone beds are thick; and these beds furnish an amount of lime for fields elsewhere. The "*Somerset Glades*" have always been famous as rich pasture lands. In the absence of limestone outcrops the Barren Measures furnish a lean, poor soil, and the use of fertilizers is necessitated.



Although the rocks at Berlin clearly belong to the Lower Barren Measure group, the term "*Barren Measures*" does not here strictly apply. Usually this group, embracing full 550′ of measures, is almost entirely devoid of workable coal seams; but at Berlin an important series of workable coal beds and limestone deposits can be recognized and traced thence to Berkley's mills on the Blue Lick. This is certainly a very unusual condition of things, but one which nevertheless prevails with more or less persistency throughout Somerset Co., though in modified form, wherever the basins are sufficiently deep to permit of an accumulation of Barren Measure rocks. (Berlin Section, plate 467.)

The coal beds range from 1′ to 7′ in thickness; in character taking an equally wide range. Two beds only of the series are of importance in a mining sense; these are the first and third in descending order. The rest are either too small or too slaty to be mined with profit, and none of them are worked except for local use.

Excellent limestone abounds. No less than four distinct bands, two of which are 10′ thick, are present in the neighborhood of Berlin. All of these deposits have been worked in turn, and each has been found to yield, when calcined, a pure white lime.

It is much to be regretted that a perfectly accurate and complete section of the entire *Lower Barren Measure group* of rocks cannot be made at any one place in this basin, for such a section would establish at once the precise geological position of the Berlin coals. But from numerous vertical sections made at other points in Somerset Co., the geological horizon of these coals is believed to have been definitely ascertained. The limestone bands of the Barren Measures maintain a regular thickness with greater persistency than the coals, and being thus more easily recognized over wide areas, are the safest guides to identification.

Now the *highest* limestone found at Berlin accords in position with the *Elk Lick limestone*, which is the *lowest* limestone deposit above water level in the Salisbury region to the southwest, and accepting this identification as cor-

rect, the *Pittsburgh coal bed* would then be from 210′ to 220′ above the surface at Berlin.

By means of this connection the compiled section in this basin can be carried without a break from a point about 200′ above the *Pittsburgh coal bed* down to within perhaps 50′ of the *Mahoning sandstone;* from thence to the Seral Conglomerate the rocks are well known. The developments between Berlin and Pine Hill church are very complete; by their aid the several coal beds and limestone strata may be easily followed throughout this distance.

A compiled vertical section of these *Barren Measures* in the Berlin region, from the Mahoning sandstone at their base to the 10′ (*Elk Lick*) limestone bed which crowns the hill summits, is given in plate 467 together with a series of six sections in different parts of the field which show the variation in interval and character of this exceedingly irregular group.*

The *Philson* and *Coleman beds*, respectively the first and second seams in the Berlin section above the Mahoning sandstone, crop in the flat north of Berlin, both thin and identified by means of their accompanying limestones. Neither bed calls for extended notice, being generally worthless, although on Mr. Coleman's property the upper bed swells out to an abnormal mass of coal and slate nearly 6′ thick. In the neighborhood of Pine Hill church the same bed shows about 3′ thick, full of dirt and slate. From thence south-westward to the valley of Blue Lick these

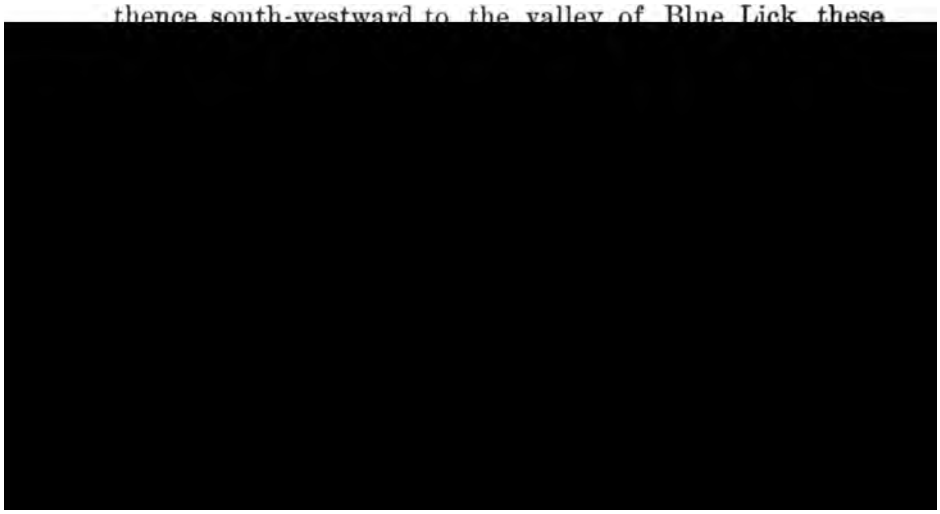


PLATE 467.

No XIV The Barren Measures in Somerset County

Comparative Sections at Salisbury, Berlin and Piedmont, Md.

From Report H2

SECOND GEOLOGICAL SURVEY OF PA.

Comparison of the Coal Measures

at

Salisbury, Somerset Co. Pa. (by J. P. Lesley, 1876)

Fig. 27.

Piedmont, Alleghany Co. Md. (by J. P. Lesley, 1877.)

Fig. 28a

SECOND GEOLOGICAL SURVEY OF PA.

1875

Fig 10.

BERLIN.

(Compiled)

Limestone.

Berlin Bed, Interval, Limestone, Shale & Slate, Platt Coal & Slate

Price Coal Bed

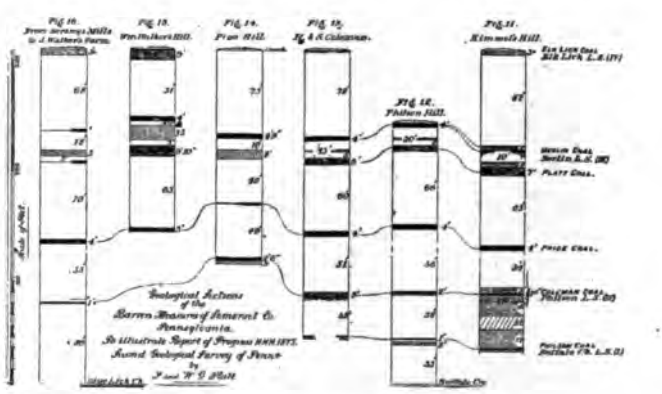
Coleman Bed. Shale. Limestone.

Poulson Bed. Limestone

Buffalo Creek or Pine Hill Sts.

Mahoning S.S.

Sections showing variation of Barren Measure Coal Beds.





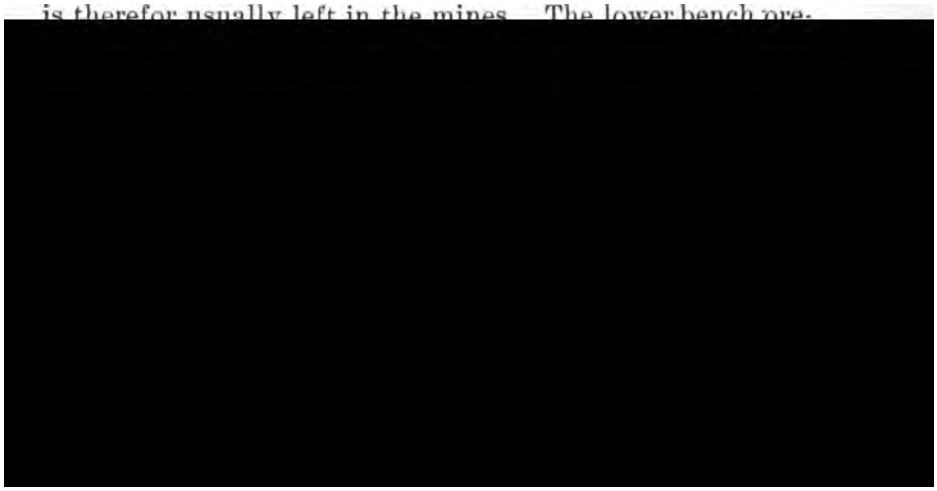
two coals remain under the high country which marks the center of the basin. The *Price coal bed* comes 60′ higher in the series, locally known as the "*Four Foot bed*," and necessarily covers a more limited area than the beds just described.* Though yielding a somewhat ashy coal it is one of the *two* important beds of this region, marked by a few distinctive and very persistent features; *first*, its invariable slate roof; *second*, the small slate band, parting the bed unevenly; *third*, the softness and extreme friability of the coal. It also carries sporadic knife edges of slate and wedges of clay material, which increase the percentage of ash in the coal. It is still an open question whether this bed will repay working on a large scale over any considerable area, as in common with other coals of the Barren Measures it changes suddenly its size and character. However it has been opened at a number of places for a local supply of fuel for the town and the farmers of the vicinity, inasmuch as the great *Pittsburgh bed* is entirely eroded from the surface and the coals of the *Lower Productive Measures* are everywhere deeply buried.

In the *Price mine* it showed the following section: coal, bony 0′ 2″; coal, good 1′ 0″; slate, knife edge; coal 1′ 2″; slate, thin, not persistent; coal 0′ 5″; slate 0′ 3″; coal 1′ 0″, total 4′ 0″. The coal is of columnar structure, and is exceedingly soft and friable, breaking and crumbling considerably in mining. An analysis shows F. C. 68.944%; V. M. 20.330%; sulphur 1.176%; ash 8.680%. The outcrop follows down Buffalo creek, keeping far above water level and shooting out into the air on a north-west rise some distance below Pine Hill station. At the Philson mine, in a neighboring ravine, the bed measures full 4′, with its usual parting of slate, and shows an interval of 60′ above the Coleman bed and also 60′ below the Platt bed. At Pine Hill church it is far below the surface.

*Its north-eastern outcrop is on the S. Musser farm, 1¼ miles north-east of Berlin, where it shows an upper bench 2′ 9″, with a few thin wedges of slate; slate parting 3″ and a bottom coal bench 1′ 10″. The bed underlies all the high plateau south-west of Berlin and stretches in an almost unbroken sheet towards Pine Hill station in Buffalo valley.

The *Platt bed* is the largest seam of the Berlin group, measuring 7′, including all its partings. It is rarely worked however, owing to the large and irregular mixture of slate as well as the enormous quantities of sulphur which it contains. Apart from the wide difference in character it shows in comparison with the Price coal, the beds may be easily recognized and located by the limestone bands which range through the hills, and also by the invariable interval of 25′ separating the Platt bed from the Berlin seam above it. In many openings it varies from 4′ to 9′ with its slates.

The *Berlin bed* is the highest of the section and the most valuable. It measures only about 4′ thick; but its comparative freedom from sulphur and slate renders it the most important coal of the series. While its area is small it is more largely accessible than any other seam. North of Buffalo creek it approaches the surface so closely that very little firm coal can be obtained from it in the vicinity of Berlin. South-west of the valley, though confined to a narrow line along the center of the trough, it sweeps in an almost unbroken sheet past Pine Hill church* down the valley of Blue Lick, going under water level at Meyersdale, to remain concealed under the Castleman river. It is 280′, more or less, below the Pittsburgh bed as mined in the Salisbury basin further south. A band of slate divides the bed unequally and nearly 6″ thick, so that the upper coal bench is therefor usually left in the mines. The lower bench ore-



the highest fields of the Coleman farms and mined for local use with a top bench of 3″; slate parting 5″; and a lower bench of 3′ 2″, yielding on analysis sulphur .744% and ash 8.390%. It passes under Pine Hill church and in the ravines to the west it has been opened by Mr. S. B. Fritz with a section 4′ 9″ thick, the top bench swelled to 8″ and the bottom bench to 3′ 8″, again showing about the same chemical quality.

The *Berlin Limestone group*, like the coals, is confined to a narrow belt of land in the center of the trough, with intervals in the region averaging about as follows:—

Limestone, No. IV, Elk Lick,	10′ 0″	
Interval,	80′ 0″—90′ 0″	
Limestone, No. III,	8′ 0″—10′ 0″	
Interval,	135′ 0″	291′ 0″
Limestone, No. II,	3′ 0″	
Interval,	40′ 0″	
Limestone, No. I,	3′ 0″	

The *Elk Lick limestone*, No. IV, is opened on Elk Lick creek in the Salisbury basin at E. Yoder's, in two layers, separated by a thin shale parting, the upper layer 2′ 6″ thick. The whole bed usually averages 6′. This bed also shows on north side of Castleman river, west of Meyersdale, and on Tub-mill run. It is 190′ below the Pittsburgh coal here. The *Elk Lick coal* over the limestone is always called a "four foot bed."

*No. XIV. In the Second or Johnstown trough.**

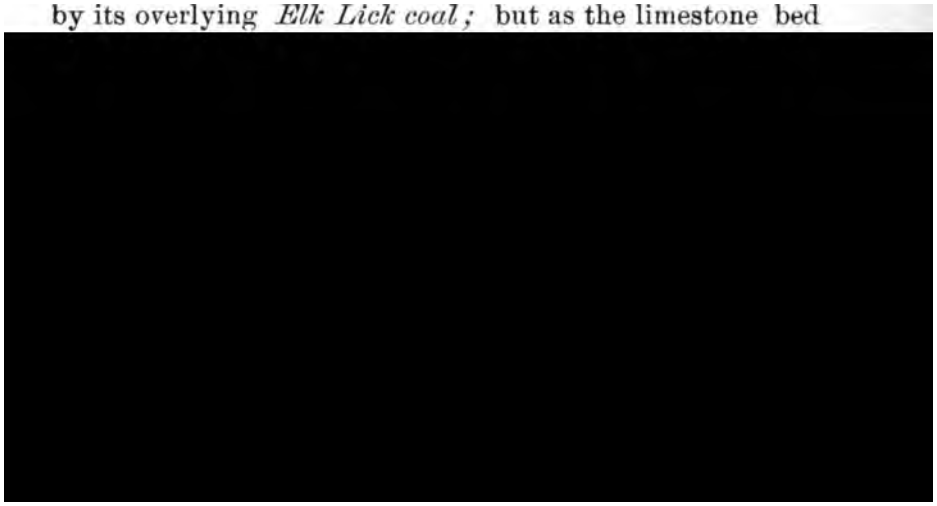
Coming into the basin from Cambria Co. the Lower Productive Measures occupy the valley and branches of Bens creek as far south and east as Forwardstown and Davidsville; but further south these coal rocks slowly disappear below water level and the *Lower Barren Measure* rocks fill in the center and sides of the basin to the extent of 400′. This allows the *Elk Lick limestone* to come into the hill tops where it is worked by Mr. Berkey a short distance south of Forwardstown, and where the *Elk Lick coal* also

* Vertical sections of this group in this basin are given in plates 421 and 426.

covers a small area between Berkey's and Harshberger's, the same bed appearing again in the vicinity of Confluence, but much reduced in thickness. The Barren Measures continue to prevail along the synclinal across the Jennerville pike and into Somerset twp., and continue as the prevailing surface rocks until the headwaters of Laurel Hill creek are reached beyond Indiantown in Middle Creek twp. where they are shifted eastward to occupy nearly all of Turkey Foot twp. between the basin and the Viaduct anticlinal. About 380′ of these rocks are included in the hills around Confluence (Plate 426).

The *Mahoning sandstone*, as a double deposit, parted by a mass of shale 15′ thick, is prominent in the Castleman section, where it is separated from the Upper Freeport coal by 25′ of soft black slates. The *Rose coal bed* is an important feature of the Barren Measures here, coming in about 100′ above bed E, but like all other coals of this group, varying considerably in thickness over small areas. In one place it is 6′ thick and was formerly mistaken, with great loss of money, for the Pittsburgh coal bed, and disastrously worked as such at Ursina. Though persistent it is commercially a worthless bed. A few thin streaks of coal occur at various intervals between this bed and the topmost (Elk Lick) limestone capping the section 380′ above bed E.

At Harnedsville, Ursina and Confluence it is accompanied by its overlying *Elk Lick coal;* but as the limestone bed



nating where there is any considerable accumulation of the group. There are some insignificant coal beds in these measures; but no iron ore beds to speak of, nor any particularly good deposits of fire clay. Several of the upper limestone beds have been spared erosion in a few localities, the Paradise settlement south of Reynoldsville being abundantly stored with limestone.

The *Mahoning sandstone* in Porter twp., along the Perrysville road is quite prominent, especially at the village of Porter. It is also found massive in the hill tops of Perry twp. In Young twp., along the Mahoning, it is more prominent than any other rock; and is at least 50′ thick. Indeed wherever its horizon is reached in this and McCalmont twps. it is a readily recognized and persistent stratum. Higher strata are best exposed along the Indiana pike south-west from Punxsuatawney, where red shale layers form the most conspicuous feature.

The Lower Barren rocks occupy a large part of the county east of the Perrysville axis. The Mahoning sandstone makes an abundant display in the south-eastern townships, especially conspicuous in Gaskill along Ugly and Clover runs. In Henderson the Barrens are 250′ thick; but aside from a few sporadic limestone beds near the top they enclose no rocks of any importance. Even the Mahoning sandstone becomes thin bedded and obscure; but in Winslow twp. it is universally massive and especially conspicuous around the heads of Big run.

These rocks overspread the uplands along the Indiana Co. line, except on Chestnut ridge, and have quite an extensive range in Henderson twp. along the Clearfield line. North of the Red Bank and Sandy Lick creek, they are scarcely represented at all. Few of the better known horizons of Somerset, Westmoreland and Allegheny Cos. can be recognized here, and only at one place, Clayville, was the *Black Limestone*, near the bottom of the group, seen.

No. XIV in Indiana County.

The Barren Measures occupy a very wide outspread in Indiana Co; but at no one place can a complete section be

measured. However a very perfect partial section of the lower half, from the *Upper Freeport bed E* to the *Morgantown sandstone* was obtained at Dilltown on Black Lick creek in the Ligonier basin, while the balance of the section up to the *Pittsburgh coal* can be added from exposures at Blairsville. As a rule exposures of these rocks are meagre and separated by wide horizontal intervals. Their coal beds are small and unimportant here as compared with Somerset Co; but some of the rock members can be recognized as steadfast, reliable horizons throughout the country*.

The thickness of the group varies but little from 600′, thus bringing about a parallelism with measurements in the western part of the state.

No. XIV in the Ligonier Valley. Indiana Co.

The Mahoning sandstone is a very conspicuous feature of the Ligonier Valley geology. In places it is well adapted for building purposes, being composed of a tough, compact mass of fine grained sand. It frequently shows a triple character, its parting shales getting thinner going west, where the deposit is a nearly continuous mass of sandstone 150′ thick, as at Blairsville and Saltsburg.

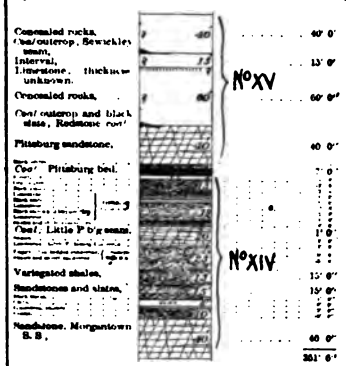
The *Philson coal* is the second bed above coal E, and has been recognized as a thin worthless seam at Nineveh and Lockport. The *Black Fossilferous limestone* is one of the



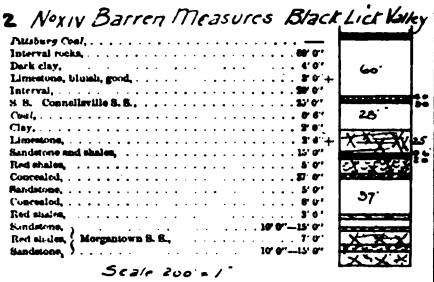
PLATE 468.

N°XV Monongahela (Upper Productive) Coal Series
N°XIV Barren Measure Series.
Vertical and Columnar Sections in Indiana Co. Pa

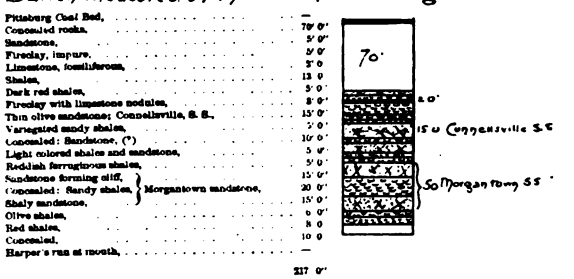
1 Blairsville or Fourth Basin



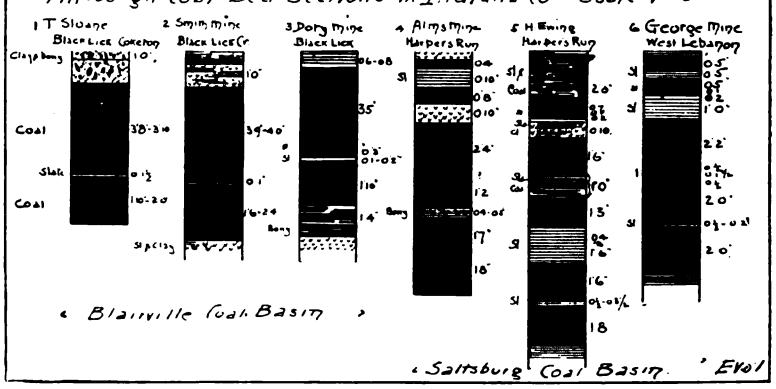
2 N°XIV Barren Measures Black Lick Valley



3. N°XIV Barren Measures. Harper's Run. Saltsburg Basin



Pittsburgh Coal Bed Sections in Indiana Co Scale 1"=8'





inches to over 6′ and in the absence of the Lower Productive Measures, it has been largely worked for a supply of local coal.

The *Mahoning sandstone* is prominent along Richards run, having a mottled appearance, but sometimes quite free from iron; it is massive, only slightly conglomeratic and nearly everywhere conspicuous.

Along Black Lick in the Ligonier basin, nearly 400′ of measures are exposed in which are included three small coals, several limestone layers and a band of carbonate of iron ore ranging near the top, known as the "*Black Lick ore.*" The Morgantown sandstone is the highest rock (geologically) in this valley; compact and often conglomeratic, and 50′ thick. The *Black Fossiliferous limestone* shows on the Kern farm at Dilltown, with divisions, 11′ thick. The "*Black Lick ore*" was benched upon nearly every hill side here, 0′ 6″ to 2′ 0″ thick. The *Philson* and *Coleman coals* attain local thicknesses of 4′ and 3′ at Campbell's mine near Armagh. The lower (4′ bed) is very much mixed with slate and worthless coal; the upper one shows a top bench of 2′; slate 0′ 2″ and coal 0′ 9″; is better though still impure.

Along Yellow creek the Morgantown sandstone does not occur owing to north-east rise in the measures along the Ligonier basin. So too the Black Lick ore and the Black Fossiliferous limestone. The Morgantown sandstone is a conspicuous rock, especially along the western side of the basin on Yellow creek. It also shows along Little Yellow creek east of Nolo, between the Irish Bottom and Gillespie's Mills. It can be traced everywhere along Chestnut ridge and at the Round Top summit it is overlaid by 100 of shale and thin sandstones containing the *Gallitzin coal*, about 3′ thick, and the *Philson coal* 50′ higher 3′ 1″ thick, with bony on top and 1″ of slate near floor. The area of both seams is limited to a few acres on Round Top. The Morgantown sandstone shows prominently along Two Lick, being a massive rock 100′ thick at the "Flats" on the South branch.

No. XIV. In the Blairsville and Saltsburg Basin.

In this trough the greatest accumulation of the Barren Measures is found along the Conemaugh; they fill the valley of Black Lick and they skirt the right bank of Two Lick in high bluffs for miles, gradually disappearing northeastward as the basin shoals up. All the measures *above* the Morgantown sandstone are nearly uniform everywhere, creating a monotonous topography; but as soon as their basal member appears above water level an immediate change occurs, producing wide flats of sand and clay, and ravines with precipitous walls of massive rock.

While streaks of coal are frequently met with, no coal bed of commercial value can be found along the Indiana Branch R. R. or northeast of the county seat in this basin. West of Chestnut ridge these measures are valueless, except for some small limestone beds, the group however everywhere showing a remarkable uniformity of thickness, with extremes of 500′ and 600′, between the Upper Freeport coal E and the Pittsburgh coal.

A good section of these rocks in the Black Lick valley, between the Campbell farm and Rankin's mill is given in Fig. 2 plate 468. The *Connellsville* and *Morgantown sandstones* are both prominent in this section; through this and the Saltsburg basins.

The *Pittsburgh limestone*, 20′ below its coal, is an important stratum throughout the Blairsville region, separated into 3 layers aggregating 5′ of good stone. The *Little*

Measures, is obscure on the Conemaugh, but shows 3′ thick at Homer. The *Black Fossiliferous limestone* is also obscure; but it occurs north of Indiana and on Crooked creek and in the Saltsburg basin.

The *Mahoning sandstone* is always conspicuous, its two members being fully 150′ thick. The *Philson coal*, beneath the upper member, shows in the Deep hollow 2 miles below Blairsville, divided into three layers, yielding over 3′ of coal, but rendered worthless by heavy clay partings. The *Mahoning sandstone* is very coarse and massive on the Bolivar road and the pike. Along Two Lick and Yellow creek it often furnishes good building stone, nearly all the stone for the Indiana court house coming from this formation near Homer. Ascending Yellow creek from its mouth it again shows in massive condition, as it does along Tearing run. It is easily recognized along Two Lick, yielding massive sandstone past the "Upper Mills." It is not so massive at Taylorsville, but becomes coarse again at Smithport. Between Decker's Point and Marion, in the northern end of the basin, it is again conspicuous, coarse grained and massive.

In the *Marion sub-basin* this formation so expands as to occupy nearly one-half of the Lower Barren Measures section, replacing nearly the whole of the Berlin group of coals. This is conspicuously true of the Conemaugh country in the Saltsburg basin. Between White's station and Saltsburg it shows three bands of sandstone, separated by no less distinct bands of shale, in all over 200′ thick. On Crooked run it is nearly as thick, and often conglomeratic.

No. XIV in Armstrong County.

The Barren Measures are about 550′ to 600′ thick. Throughout all the southern townships they make the valleys as well as the uplands; northwards they occur in isolated patches on the summits of the hills, due to structural causes largely.

The *Crinoidal* and *Black limestones* can be detected, as in the Pittsburgh region along the Monongahela river; and

also the *Connellsville* and *Morgantown* sandstones. The *Mahoning sandstone* base is everywhere a distinguishing feature. The group characteristics are well shown in vertical section plate 469 Fig. 1. Along the Kiskiminitas the series is readily divisible into two portions, a lower nearly all sandstone, and an upper chiefly variegated shales, with bands of sandstone. No coal seams of any practical importance are found, nor is limestone represented there in any abundance.

In the *Crooked Creek region* these rocks are about 575′ thick. Both the great sandstone rocks are shaly here, but a small coal bed (*Philson seam* ?) occurs about 100′ above the Upper Freeport, and has some local importance. Neither of the two characteristic limestones were noted in this part of the field, and the Mahoning sandstone, with wide extremes in thickness and character, is always present but never shows as massive as along the Kiskiminitas.

On the *Cowanshannock* only about 300′ of these measures are left uneroded, with shale largely prevailing. The *Gallitzin coal bed* however is one feature of importance.

Along *Pine creek* the section is reduced to one-third its thickness along the Kiskiminitas and frequently only the Mahoning sandstone is left uneroded.

Along the *Mahoning* about 200′ of the Barren Measure rocks occupy the hills in the vicinity of the old Ore Hill furnace and about 300′ of the same rocks show in the neighborhood of Manorville, devoid of economic interest.

Plate 469.

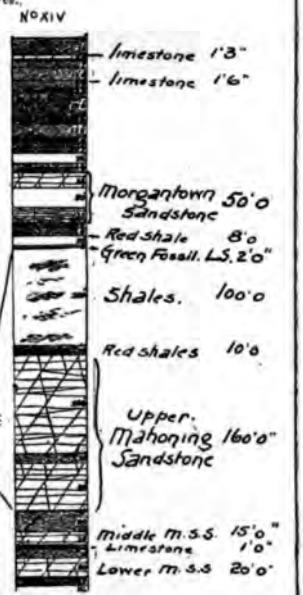
No XIV

Armstrong County Pa Sections. Report H5

No XV.

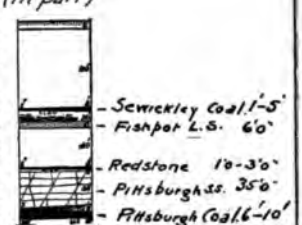
Fig. 1. The Lower Barren Measures.

Clay underlying Pittsburg coal,		2' 0"
Slate, sandy,		15 0"
Sandstone, micaceous, greenish grey,		4' 0"
Limestone, impure,		1' 3"
Shales, calcareous,		2' 3"
Shales,		7' 0"
Shale, greenish,		12' 6"
Limestone, blue, non-fossiliferous,		1' 8"
Clay, impure,		2' 0"
Slate, greenish, sandy,		4' 6"
Clay, impure, with nodules,		2' 6"
Slate, greenish,		3' 6"
Sandstone,		1' 9"
Shales, olive, with *limestone* nodules at top,		22' 6"
Slate, greenish,		8' 0"
Slate, grey,		13' 6"
Shale, grey and purple,		5' 0"
Sandstone,		1' 0"
Shale, greenish,		5' 0"
Shales, variegated, sandy,		3' 0"
Concealed (sandstone?)		10' 0"
Shales and S. S., light colored,		5' 0"
Shales, reddish, ferruginous,		5' 0"
Sandstone, forming cliff,		12' 0"
Concealed; sandy shales?	Morgantown S. S.	20' 0"
Sandstone, shaly,		13' 0"
Shales, olive,		6' 0"
Red shales,		8' 0"
Concealed.		10' 0"
Green Fossiliferous Limestone,		2' 0"
Coal,		?
Concealed interval, consisting chiefly of Shales,		100' 0"±
Red shales,		10' 0
Sandstone,		100' 0"
Shales, sandy,	Mahoning Upper S. S.,	10' 0"
Sandstone,		50' 0"
Coal smut,		
Shales, variegated,		20' 0"
Sandstone, massive, Mahoning Middle S. S.,		15 0"
Coal smut,		
Shales,		2' 0"
Limestone, ferruginous and ore nodules,		1' 0"
Shales,		10' 0"
Sandstone, massive, Mahoning Lower S. S.,		20' 0"
Slates, overlying Freeport Upper coal,		8' 0"
Total thickness,		360' 0"



2. No XV Monongahela River Series (in part)

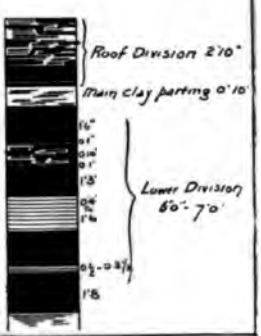
Great Limestone, present only in part,		5' 0"
Concealed rocks,		80' 0"
Coal bed, Sewickley,	1' 0" —	5' 0"
Black slate and clay,		10' 0"
Limestone, Sewickley, (Fish pot limestone,		6' 0"
Interval,		40 0"
Coal bed, Redstone seam,	1' 0" —	3' 0"
Clay, impure,		2' 0"
Sandstone, *Pittsburg SS.*,		35' 0"
Slates,	1' 0" —	8' 0"
Pittsburg coal bed,	6 0" —	10' 0"
Total thickness,		207' 0"



3 Pittsburgh Coal Bed. West Lebanon Field

Scale 1" = 8'

Slate and coal,	Roof division,	2' 0"
Coal,		0' 7½"
Slate,		0' 1"
Coal,		0' 2"
Slate and clay, main parting,		0' 10"
Coal,		1' 6"
Slate,		0 1"
Coal, slaty,		0' 10"
Slate,		0' 1"
Coal,		1' 3"
Slate,		0' 4"-1' 0"
Coal,		1' 0"
Slate,		0' 0½"-0' 3½"
Coal,		1' 8"
Slate,		—
Total,		12' 4½"





The *Mahoning sandstone* is massive and coarse grained on the hills overlooking New Bethlehem, and is no less conspicuous in the hill tops at the Bostonia mines. In the same condition it reappears in the Mahoning valley at Putneyville. At Kittanning it is double, consisting of an upper sandstone and slate 60′; a middle slate 10′, and a lower sandstone 20′. It is also magnificently exposed along the Allegheny valley around Freeport and on the Kiskiminitas and the Buffalo, from all of which places it is quarried for building purposes, furnishing a fine grained, slightly micaceous sandstone, somewhat mottled from specks of iron.

*No. XIV in Westmoreland and Fayette Cos.**

The *Barren Measures* in the Ligonier valley occupy the center of the wide basin between Laurel hill and Chestnut ridge completely in Westmoreland Co. thrusting the *Lower Productive Coal Measures* back to narrow strips on the flanks of the mountains; but in Fayette, owing to the elevation of all the measures, these rocks are more thinly distributed and the erosion of the Youghiogheny and its branches have cut completely to their base and exposed the underlying coal measures. General sections of this group in the Ligonier valley are given on plate 470, Figs. 2 and 3.

The most marked difference in this series on this side of Laurel hill, from that governing western Fayette and Westmoreland, is within the first 50′ below the *Pittsburgh coal*, which here contains no limestone whatever.

The *Little Pittsburgh coal*, rarely over 15″, was seen at Ligonier and elsewhere, and though too thin to warrant mining, it is strangely persistent wherever the Barren Measures are exposed in this and adjoining counties, east and west. The underlying limestone is equally persistent; a bluish stone and yielding the best lime of the Barrens,

*This district was reported upon separately by Dr. J. J. Stevenson; the Ligonier valley in report K3 and the balance of the district, west of Chestnut ridge, in report K2.

and therefore of great importance to the agricultural interests of the Ligonier valley.

The great *Connellsville sandstone* west of Chestnut ridge is here only shale, extending down 68′ to a thin but quite persistent coal. The *Morgantown sandstone* shows as 100′ thick in the section, but is not always massive. It carries an iron ore bed immediately on top. It is rarely exposed in the south end of the Ligonier valley, and then its section is obscure. It occurs at Wharton furnace in Fayette, and its massive sandstone layers were used for building and lining the stack. In Westmoreland Co. it is massive and compact in Donegal and Mt. Pleasant twps., but it deteriorates north to become shale on the Loyalhanna, well exposed at Ligonier, its bottom layers quarried as flagstone. It continues this character northward; gradually breaking down to shale on the Conemaugh.

The *Elk Lick coal.* the equivalent of the *Barton coal* west of Chestnut ridge, occurs near the middle of the group, thoroughly persistent, and with a thickness of 18″ to nearly 4′. It was once mined near Wharton furnace in Fayette and near Ligonier in Westmoreland Co.

The *Crinoidal* (Green Fossiliferous) *limestone* was seen only at a few widely separated localities; mostly argillaceous. Below it the interval is mostly shale, but on Dunbar creek (Fayette) and Five Mile run (Westmoreland) a thin coal bed occurs near the base, possibly the equivalent

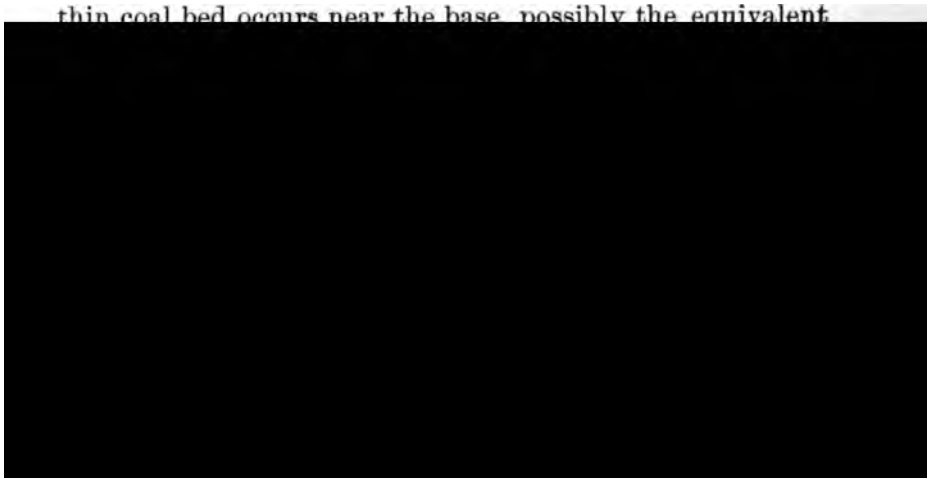
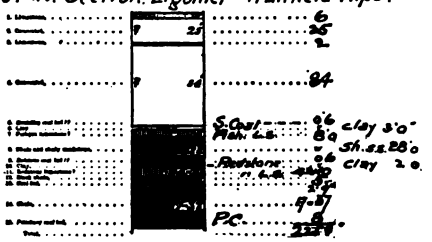


PLATE 470.

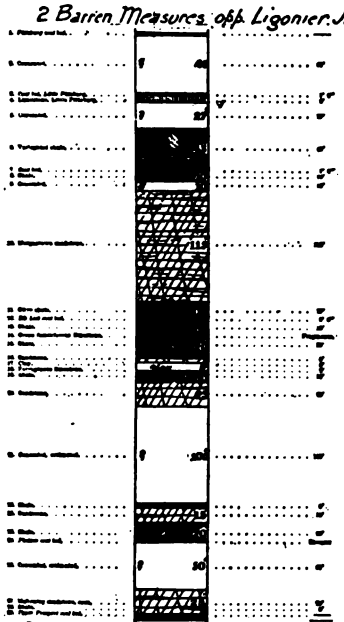
Sections in the Ligonier Valley. Westmoreland & Fayette Co^s Pa

No XI Monongahela Series. No XIV. Barren Measures. No XV. Pittsburgh Coal.

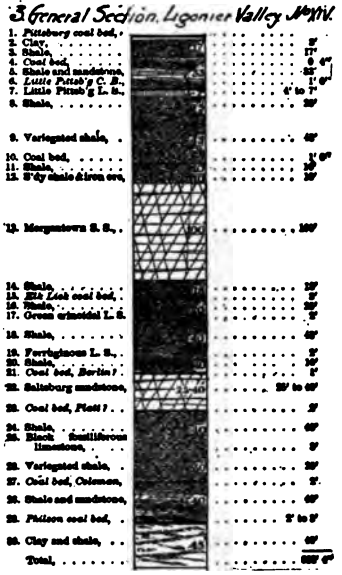
1. No XV. Section. Ligonier & Fairfield Twps.



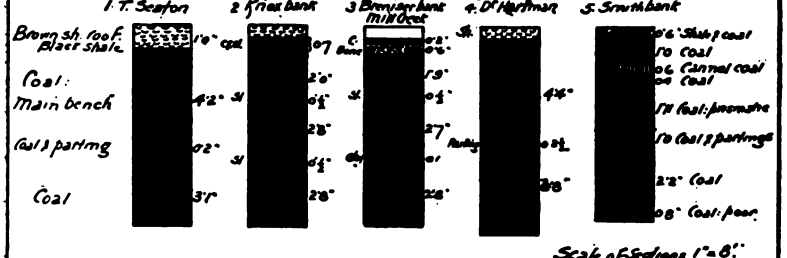
2 Barren Measures, opp. Ligonier. No XIV.



3. General Section. Ligonier Valley No XIV.



No IV. Columnar Sections of the Pittsburgh Bed. Westmoreland Co.





dark in color; frequently wholly replaced by calcareous shale. Further north it carries more lime, only to deteriorate along the Conemaugh. Along the base of Laurel hill in Westmoreland it becomes an iron ore; at all localities it is richly fossiliferous.

The lower half of the Barren Measure group is not well exposed for measurement and its rocks vary greatly in character and thickness.*

The *Price coal* of Somerset may be the small coal coming in 3′ to 5′ beneath the Black Fossiliferous limestone here, associated with a worthless iron ore. The *Coleman (?) coal* of the section occurs about midway between the Black limestone and the Philson coal; seen on Indian creek near Springfield. This whole interval holds variegated shales continuing to the Black limestone.

The *Philson coal* of Somerset is identified here as the first coal above the Mahoning sandstone, from 40′ to 90′ above bed E, the variation of interval depending largely on the presence or absence of shale between the coal bed and Mahoning sandstone.†

The *Mahoning sandstone*‡ is everywhere present in the Ligonier valley where its horizon is reached; frequently single, 40′ to 60′ thick, varying from coarse to fine grained;

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*The summary of evidence adduced during the survey of the Ligonier valley in 1878 served to indicate the identity of the *Crinoidal limestone* with the *Elk Lick limestone* of Somerset, despite their different characteristics; but the *Black Fossiliferous limestone* was not mentioned as occurring in Somerset and the Lower Barrens are at least 50′ thinner here.

†It shows 2′ thick near Farmington in Fayette; in Stewart twp. 3′ thick and 65′ above bed E. In Springfield twp. on Laurel Hill run 5′ thick, resting directly on the Mahoning and 45′ above bed E, but on Indian creek the interval is 55′. On the Loyalhanna, the interval is 80′, with much shale between the coal and the sandstone, and 1′ thick; on the P. R. R. the interval is 90′. The bed therefore has no economical importance.

‡In Stewart twp. north from Ohiopyle Falls it reads: top sandstone 30′; coal 7′; concealed 10′; limestone and iron ore 2′; sandstone 35′. The sandstone layers are both gray, soft and fine grained. The coal here is double, divided in center by 1′ of clay; but rather carbonaceous shale than good coal. The ore and limestone are widely distributed and the former is the same bed once mined at the Springfield mines below Indian creek on the Youghiogheny, the equivalent of the *Johnstown iron ore bed.*

sometimes massive, flaggy and merely shale and shaly sandstone. But over a large portion of the district the sandstone is double, the divisions being separated by an interval of shale, sometimes containing coal and limestone.

North of the National road the Mahoning limestone is single along the east face of Chestnut ridge, except in Mt. Pleasant twp. of Westmoreland where it is 45′ thick, containing 20′ of upper sandstone; coal 3′; shale 2′; ore 8″; shale 2′; ferruginous limestone 4′; shale 8′ and sandstone 5′. It shows the same in Fairfield and St. Clair twp., without its limestone member, and this character persists along Laurel ridge south to the line of Ligonier twp; north towards the Conemaugh it is a single sandstone formation.

*No. XIV. In Westmoreland and Fayette, west of Chestnut Ridge.**

The rocks of this series are exposed along the west flank of Chestnut ridge and on the arches of the several anticlinals of the district. On the *Blairsville* and *Saltsburg axes* they occupy a broad strip of comparatively inferior land extending from the Conemaugh south to Big Sewickley creek, and on the *Fayette arch* from the Sewickley to Springfield twp. of Fayette where the Pittsburgh coal crosses the axis and buries the Barren Measures.

These same rocks are exposed over the Roaring Run and Pin Hook anticlinals north of the Pittsburgh and Greens-

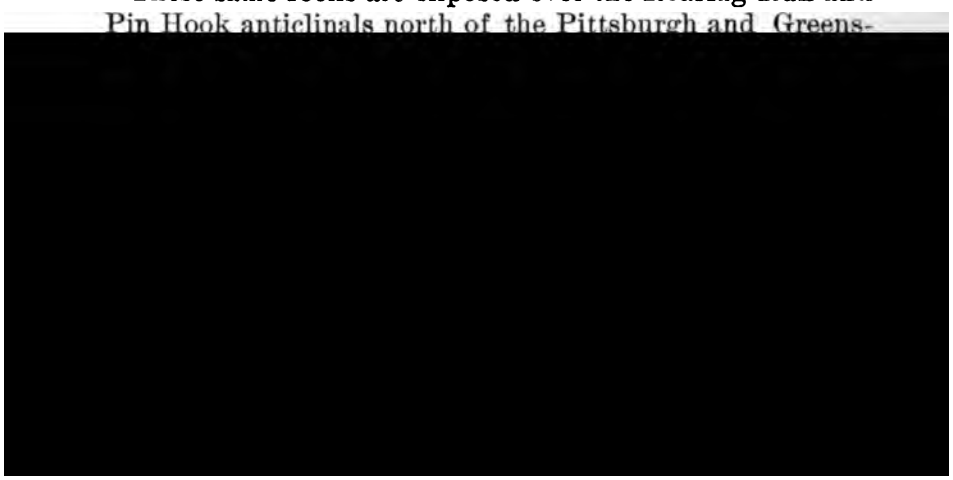
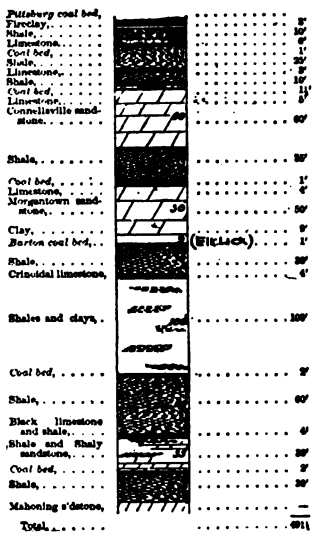


PLATE 471.

No XIV Barren Measures or Pittsburgh Series W of Chestnut Ridge.

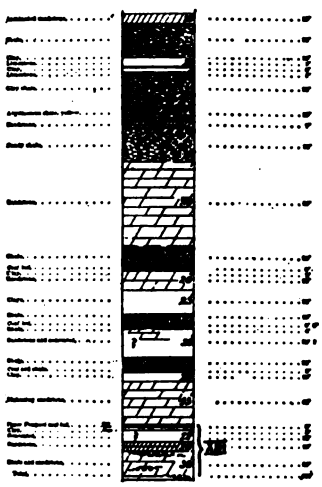
Westmoreland and Fayette Co's.

1 General Section of No XIV.



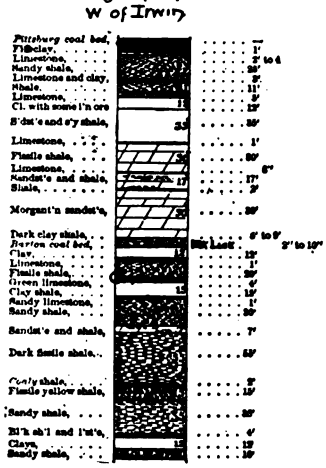
2 Tyrone twp Youghiogheny River.

(compiled.)



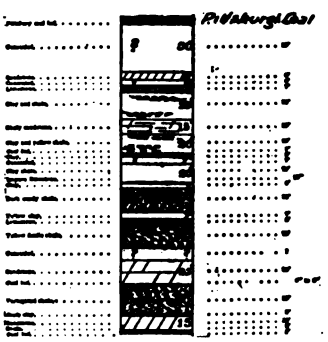
3 N. Huntingdon twp Westmoreland.

W of Irwin



4 Unity twp Westmoreland.

west from Beatty P.R.R.



FWD'l



The *Morgantown sandstone*, *Barton coal* and *Crinoidal limestone* from a most regular and well defined group. The first is usually a massive rock; seen in Springfield and Georges twps.; in the hill tops on Redstone creek; a bold sandstone on Dunbar creek and on the Youghiogheny; along the South West Penn. R. R. in East Huntingdon and along the P. R. R. in North Huntingdon; on Beaver run in Salem twp. and generally throughout Westmoreland. It is compact, with a gray color, slightly tinged with red, and an excellent building stone.

The *Barton* (Elk Lick) *coal* is nowhere of economic thickness for mining, but very persistent here as well as in West Virginia and in this district varies from 6″ to 18″, and when more than 1′ thick it is double. The *Crinoidal limestone* character is the same as in Allegheny and Butler; greenish-gray color, weathering into rough surfaces owing to innumerable crinoid fossil stems it contains. The *Connellsville sandstone* is also quite persistent as sandstone or sandy shale at almost all exposures; 50′ below Pittsburgh coal on Dunbar creek, but varying up to 80′. Well exposed on

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ularly and can only be determined approximately, owing to excessive changes in the character of the rocks.

On Dunbar creek a definite measurement of whole series was obtained, showing thickness to be nearly 520′; on Cove run, N. Union twp., of Fayette, same interval is little more than 480′; in extreme southern portion of district, on the Monongahela river, it is little more than 400′; on the Youghiogheny river, under Saltsburg axis, near Layton station, the thickness is certainly much greater, for at one locality 520′ were measured directly without reaching *Pittsburgh coal*, though the base from which measurements began is fully 100′ above Upper Freeport coal. The interval here is certainly not less than 560′ from the Mahoning sandstone to the Pittsburgh coal. Beyond this northward the series seems to be quite constant, for on the Penna. R. R., the *Black limestone* is at 416′ below the Pittsburgh coal, which is about 30′ less than at Dunbar. No satisfactory determination of intervals between Green limestone and Freeport coal was made on Beaver run or Loyalhanna, but on the Conemaugh, above Saltsburg, 230′ were measured above Mahoning sandstone without reaching the limestone, which, judging from a section obtained in Indiana Co., is probably 50′ higher. In this region the distance from the Pittsburgh coal to the Green limestone varies from 275′ to 300′, so that the lower barrens must have a thickness of not far from 550′. Along the Allegheny river the Pittsburgh coal and Upper Freeport coal are 660 feet apart near Verona.

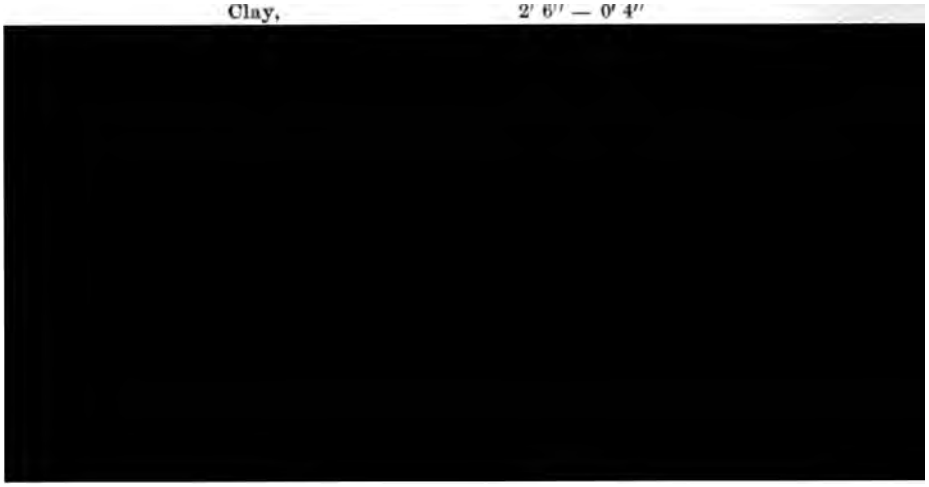
Georges creek, along the Redstone and on the Youghiogheny, on both sides of the Fayette axis.

Below the Green Crinoidal limestone the variations are excessive. In the southern part of the district the first 100′ are shales and clay ; at times however, as on the Monongahela above New Geneva, massive sandstone occurs, wanting along Chestnut ridge. On the Youghiogheny there are some great sandstones in the lower part of the section, and some coal beds of local importance. On Jacobs creek, sandstone and shales; on the P. R. R., under the Roaring Run axis, the interval is fissile shale almost to the Black limestone, and a similar condition prevails under the Saltsburg arch. But on the Conemaugh there is a series of massive sandstone under this axis (Special sections west of Chestnut ridge on plate 471.)

The coals of this part of the section are always variable and thin; but one is justified in saying that from 5′ to 30′ above the Mahoning sandstone there is a coal bed everywhere in the ditsrict. Both at the top and bottom of the section iron ore occurs,* though the quantity has not always economic value.

The *Pittsburgh ore group* is as follows :—

	Pittsburgh coal bed,	—
	Clay,	2′ — 8′
1	*Blue lump ore,*	1′ — 6″—0″
	Clay,	1′ 6″ — 0′ 4″
2	*Condemned flag ore,*	1′ 0″ — 0′ 0″
	Clay,	2′ 6″ — 0′ 4″



The *limestones* of the Barren Measures are equally variable with the other rock members. In the West Virginia section there are eight different layers, aggregating 28′; at New Geneva on the Monongahela there are six layers, with a total of 44′; at Dunbar there are but three with a thickness of 28′. Under the Blairsville axis on the P. R. R. there are five showing in all 30′, while under the Roaring Run axis eight, with a total of 22′.

The *Mahoning sandstone* is persistent, but sometimes represented by shale, and varies from 30′ to 80′ in thickness. It is often double, holding a worthless coal between

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only. The same bed shows on west side of Blairsville trough to National road, yielding iron 39% to 42%; sulphur .011% to .041%; phosphorus .70% to .089%.

The "Flag Ore" beneath the Blue Lump is persistent, but shows great variation at Fairchance. The "Big Bottom" is co-extensive with the Blue Lump; in Lisbon basin absent except near West Va. line. Mined at Fairchance, Oliphant's, Fuller's and Beattie's; thickness 10″ to 18″. Compact and slightly inferior to Blue Lump chemically. The Red and Yellow flag beds are more local, occurring only south of National road, along east coal-crop. North from Lemont the whole series disappears and is replaced by another set of beds, as below New Geneva (see plate 455.)

The sections at Frost station and Dunbar are :—

Clay shale,	8′ 0″ — 2′ 0″
Ore bed,	0′ 9″ — 0 11″
Clay,	1′ 0″ — 0′ 3″
Ore bed,	0′ 10″ — 0′ 3″—4″
Clay,	0′ 2″ — 2′ 0″
Ore bed,	1′ 3″ — 0′ 3″
Clay,	— — 1′ 2″
Ore bed,	— — 0′ 1″

At Dunbar the two upper beds have been mined; contain about 30% iron 1.11% sulphur and 0.44% phosphorus. They thin out and disappear at Connellsville.

In the *Greensburg basin* there are some loc al deposits of ore under Pittsburgh coal and to a limited extent similar deposits show in Greene, Washington and Allegheny Cos.

The *Johnstown ores* contain two bands of local importance. The upper is the "*Snake Den ore*," seen at Georges creek, near Crow's mill; on Cove run above Lemont furnace. It shows a fair carbonate, in compact layers 8″ to 14″ thick.

The *Johnstown ore* proper lies almost directly on Mahoning sandstone and attains greatest prominence along Chestnut ridge, though of uncertain occurence north of the Youghiogheny. Varies greatly in quality and thickness. Principal localities Jacob's creek east of Chestnut ridge axis; Dunbar (ferruginous clay); Cove run 2′ thick; Beattie's 2′ 6″; on Redstone creek, four layers, in all 1′ 10″, distributed through 5′ 2″ of clay.

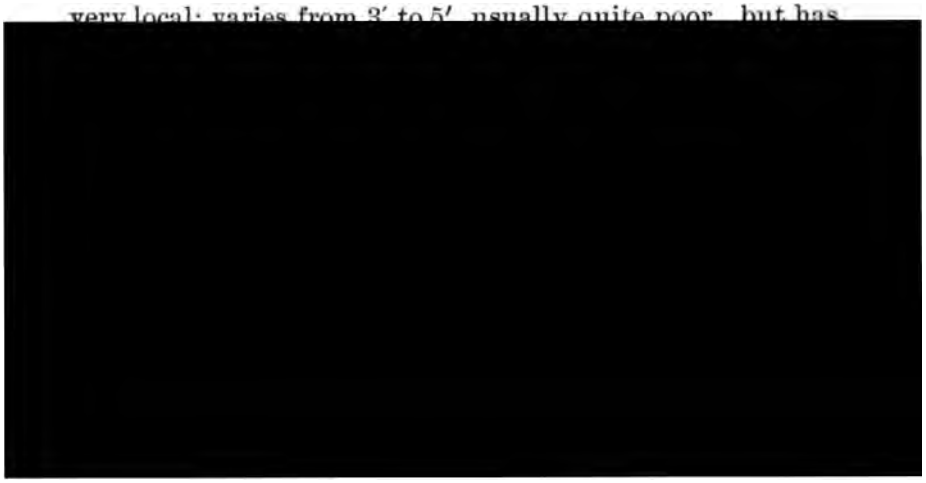
its two divisions and carries the Johnstown ore bed on top.* On Dunbar creek the two divisions are 35′ and 40′ thick; the coal 3′. The rock is more or less flaggy and coarse-grained. To the north the sandstone appears to diminish in thickness, and on the head waters of Jacobs creek in Westmoreland the interval between bed E and the Johnstown iron ore is only 35′. Under the Roaring Run axis, on Beaver run and the Conemaugh, it is a sandstone nearly 50′ thick.

No. XIV in Butler County.

The *Barren Measures*† cover the south half of the county, and rising gently northward, occupy smaller and smaller patches of highest land until no traces of them remain north and east of Crooked creek. At Millerstown there is a locally workable coal bed in the Mahoning sandstone member of this group.

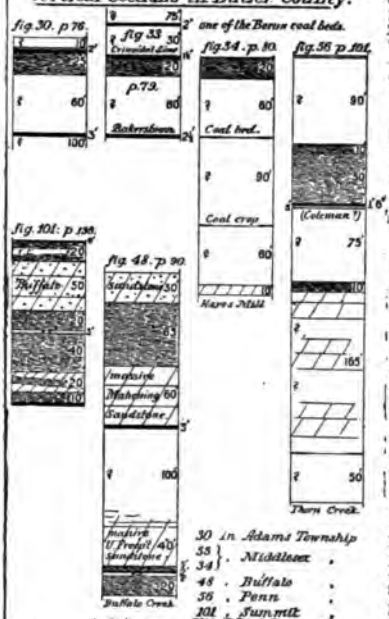
Neither the *Bakerstown coal bed* or the *Pine Creek limestone* were detected in northern Butler; nor is the *Brush Creek coal* of any importance. The *Buffalo* or *Mahoning upper sandstone*, so massive in the lower end of the county, is usually replaced by soft clay shales and argillaceous sandstones in the north.

The *Millerstown coal* occurs in the Mahoning sandstone, 35′ to 50′ above bed E, and would probably represent the *Gallitzin bed* of the Allegheny Mountain section. It is very local; varies from 3′ to 5′, usually quite poor, but has



No XIV Barren Measures or Pittsburgh Series in Butler Co

Vertical Sections in Butler County.

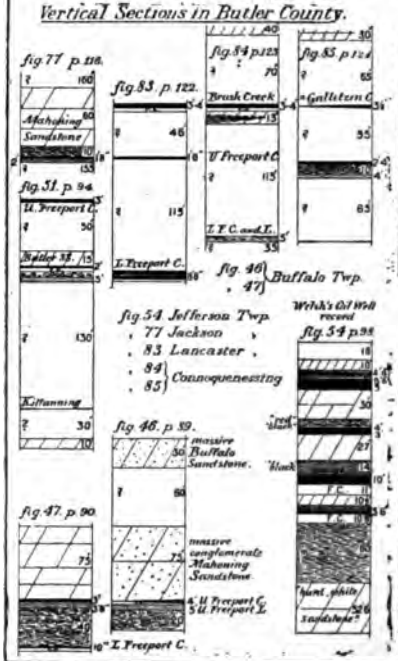


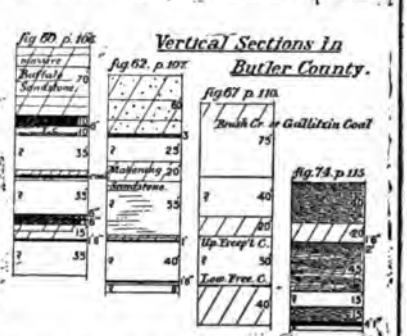
General Section of the Barren Measures in Allegheny County.

Pittsburgh Coal Bed.	
Concealed, ...	20′
Pittsburgh Upper Limestone, .	2′
Variegated Shales, ...	65′
Pittsburgh Little Coal, wanting.	
Pittsburgh Lower Limestone, .	5′
Red Upper shale, ...	20′
Concealed, ...	70′
Morgantown SS	45′
Small coal, ...	—
Variegated shale, ...	50′
Elk Lick Coal, ...	0′ to 3′
Elk Lick Limestone, ...	0′ to 5′
Variegated Shales, ...	35′
Berlin Coal, wanting.	
Green Crinoidal Limestone, . .	2′ to 3′
Platt (?) Coal, ...	0′ to 1½′
Red Lower Clay Shale, ...	30′
Sandy Shales and Shaly SS., .	50′
Bakerstown Coal, ...	0′ to 4′
Shales and Sandstones, . . .	40′
Pine Creek Limestone, ...	2′
Buffalo (Mahoning Upper) SS., .	60′
Brush Creek Limestone, . . .	1′ to 2′
Dark Shale, ...	10′ to 15′
Brush Creek Coal, ...	0′ to 3′
Shale, ...	20′
Mahoning Sandstone, ...	40′ to 80′

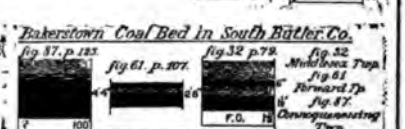


Vertical Sections in Butler County.

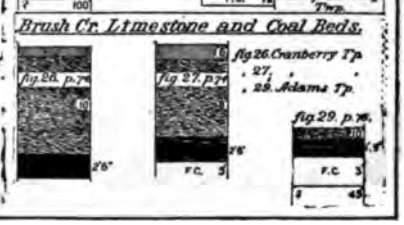




Bakerstown Coal Bed in South Butler Co.



Brush Cr. Limestone and Coal Beds.





bands of rather soft shaly sandstone. In Brady twp. it caps the hills as a massive sand rock, but usually rather shaly sandstone.

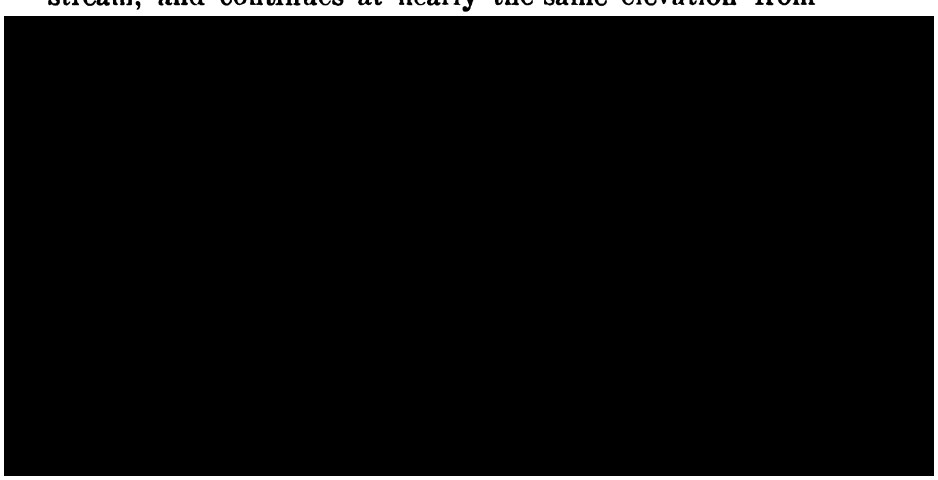
In southern Butler, owing to the gradual south-west slope of the measures, these rocks are much more fully represented, but not to the extent that they are in Allegheny Co. still further south. Various vertical sections of the group and its included coal beds are given in plate 472, including a general section in Allegheny Co., which stands as a type of the district, and shows the complete sequence from the *Pittsburgh coal* down to and including the *Mahoning sandstone.*

The *Green Crinoidal limestone*, lying about 315′ below the Pittsburgh coal bed, may be taken as the approximate middle of the Barrens, and wherever present forms an excellent key-rock for the measures above and below it. It is a most persistent member of the group, very generally present throughout the entire district in Allegheny, Beaver and Butler, as a dark, bluish, or greenish gray tough limestone, and breaks with a granular surface, much resembling that of a coarse sandstone; always crowded with stems of crinoids. The *Platt* (?) *coal* occurs immediately below the limestone, from 0′ to 1½′ thick, though frequently absent and never obtains workable thickness. The *Price coal bed* of Somerset Co., occurring beneath the succeeding barren red clays, seems to be wanting in the western part of the state. The *Bakerstown* (Coleman ?) *coal bed*, 405′ below the Pittsburgh coal bed, has been mined for a long time at Bakerstown in Allegheny Co., and gets its name from that locality. It is very irregular in its deposition and is well developed around the heads of Breakneck and Glade creeks in southern Butler; on land of Mr. Park, in Adams twp. it becomes locally a valuable coal 3′ thick. The *Buffalo* (Upper Mahoning) *sandstone* is often a very massive conglomerate rock, and has been given its separate name by Mr. White on account of attaining its maximum development along the waters of Buffalo creek, stretching in a solid bed of conglomerate to near the Beaver Co. line, keep-

ing well up in the hills above the streams and making a wilderness of the country where it forms the surface rock. The quartz pebbles in it are very numerous and often as large as hazel nuts; traced south and west into Allegheny and Beaver Cos. it looses its conglomerate character and becomes in many portions of Beaver Co. a mere sandy shale. It is probably identical with the *Stillwater sandstone* of the Ohio reports. The *Brush Creek* (Philson) *limestone* occasionally comes in below this Buffalo sandstone, frequently seen along Brush creek in Cranberry twp., and is never absent over a large area; sometimes as a compact limestone 1′ to 2′ thick and again as a black calcareous shale 4′ to 5′ thick. It is probably equivalent to the limestone in Ohio above Coal No. VII.

Between the Big Beaver and the Connoquenessing the blossom of this coal is frequently seen 60′ to 80′ above the Upper Freeport. At one point in North Sewickley twp. it becomes a bed of cannel coal 5′ thick and tolerably good. It is Coal No. VII of Ohio.

The *Mahoning* (Lower Mahoning) *sandstone*, or bottom member of the Barren Measure Series, is a name restricted to the massive sandstone which so often immediately overlies the Freeport upper coal. It comes out of the bed of the Ohio river at the mouth of Killbuck run, in Allegheny Co., and rising gradually to the north-west, caps the river bluffs at the mouth of the Big Beaver, 250′ above the stream, and continues at nearly the same elevation from



below its limestone, but closer to it on Brush creek in Butler Co. from whence it receives its name.

In Adams twp. the Brush Creek coal is opened on lands of Davis and Dunbar 1′ 9″ thick, carrying 1″ slate 8″ from top. Further up Breakneck the *Bakerstown coal* shows east of Parks mill 6″ to 3′ thick. It is locally important in the absence of all other better beds. In Middlesex twp. the same coal at Mowry's varies from 1″ to 1′, and is chiefly stripped; the *Crinoidal limestone* is 80′ above it, and the *Elk Lick coal* 30′ higher and 2′ thick on Mr. Hay's land.

In Clinton twp. the Buffalo sandstone shows 100′ above bed E, massive and conglomeratic, capping the hill tops, and in Buffalo twp. both members of the Mahoning sandstone reach their maximum development, each averaging 60′ to 70′.*

No. XIV in Lawrence and Beaver Counties.

The same vertical section plate 472 and remarks just applied to a description of the *Barren Measures* in Butler Co. avail here; the measures are the same and show about the same intervals and variations. In Lawrence Co. these rocks are confined solely to the southern tier of townships, and even here scarcely more than 100′ of the *Mahoning sandstone* at their base is left uneroded from the hill tops; but the upper (Buffalo sandstone) member is often quite massive, and has played an important part in preserving the coal beds of this area.

In Perry twp. it shows in many places as a typical conglomerate, sometimes a mere mass of pebbles of all sizes up to a hickory nut. The *Brush Creek coal* also occurs under this upper member, separated by about 5′ of shales; not at

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to occupy the position of the Gallitzin coal bed of Cambria and Somerset Cos. It is about 75′ above the Upper Freeport coal on Brush creek and at Mr. Hain's bank it shows two benches 1′ and 1′ 4″ thick, separated by 1″ of slate. Near the head of Crow's run this coal is mined on lands of Mr. Steele and Mr. Lovell where it is 3′ thick and quite good.

*Various other references to the local condition of these Barren Measure rocks, too numerous and too unimportant (economically) to give in detail here, are recorded in Rep. Q pp. 73 to 141.

all persistent, often present and absent on adjoining farms. Its area is limited but at some few places it shows an excellent coal. It is generally separated into two benches, divided by a band of slaty coal near the middle, from 2″ to 6″ thick. The upper bench is inclined to run into a "block" variety, and as such was mined and used raw in the Lawrence furnace as taken from the Miller bank. It is pure, with a low percentage of sulphur and ash, 40% of volatile hydrocarbons and 55% fixed carbon. It is also found above Wurtemburg in Wayne twp., in a patch of a few acres. Beneath it occasionally is found the *Brush creek* ("Summit") *limestone bed**, sometimes 5′ thick.

The *Lower Mahoning sandstone* certainly occurs wherever the Brush Creek measures are exposed; but its character was nowhere well exposed, and it probably exists as a sandy shale, without massive sandstone, to judge from the topography of the country holding it. But west of the Big Beaver in Beaver twp., the very base of the stratum is seen capping the hill 1 mile south of Wampum, and it is here quite massive.

No. XIV in Beaver County.†

In *Beaver Co.* the Barren Measure section (see plate 473 of General Sections in S. W. Penna.) is continued upwards to include the *Morgantown sandstone* north of the Ohio river, and hence includes the horizon of the *Elk Lick coal*



Goss, where it was found 2′ thick. Its limestone and the still lower *Berlin coal* of Somerset Co. are mostly wanting; but the *Crinoidal limestone* is as persistent here as in Allegheny and Butler, everywhere strongly characterized by the crinoid remains and peculiar lithology, and occupies considerable areas. It is well exposed 100′ beneath the summit of the "Big Knob"; but as this unique dome rises 300′ above all the surrounding country, its position here is quite isolated. The *Bakerstown coal* is the next well marked feature of the section, absent in North Beaver, but found above Georgetown in South Beaver as a 6′ bed of cannel and bituminous coal, but purely local here, once mined on Mr. Peter's land and used formerly for the distillation of oil.

The *Buffalo* (upper Mahoning) *sandstone* in this county is largely sandy shale, beneath which the Brush Creek coal and limestone occurs as persistent strata. Between the Big Beaver and Connoquenessing the blossom of this coal is frequently seen 60′ to 80′ above bed E, and at one point in North Sewickley twp. it becomes a 5′ bed of cannel. The *Mahoning sandstone* caps the river bluffs at the mouth of the Big Beaver and continues a marked feature of the topography 250′ above water level along the Ohio to the State line.

South of the Ohio river the section is continued upwards from the Morgantown sandstone to include the Pittsburgh coal along the Washington Co. line; but in this area of course the lower part of the Barren Measures are largely concealed. In Hanover twp. on this southern line the *Morgantown sandstone* is seen all along Traverse creek, and is always a compact rock; and the *Crinoidal limestone* is frequently exposed on both Big and Little Traverse creeks. The former sand rock also continues its exposure along Raccoon creek in Independence to the mouth of Service creek, compact, with shaly sandstone below, making cliffs 100′ high. But the Crinoidal limestone is even more widespread and persistent here, 2′ to 4′ thick and frequently burned for lime. It is the highest stratum exposed in

Hopewell twp., but shoots out of the hill tops north in Moon twp. Here the *Mahoning sandstone* is prominently exposed, along the Ohio and up Raccoon creek. It is extensively quarried for 3 miles along the river above Philipsburg to furnish Pittsburgh with much of its building stone. It shows the same character in Raccoon twp. In Greene twp. the Barren Measures are exposed from the Morgantown sandstone to the base. The Crinoidal limestone is well exposed, but the section below it to the Mahoning is largely obscure. The latter rock is massive and often conglomeratic, showing massive walls along Big Mill creek to above Hookstown. Various local sections and coal bed intervals are given on plates 462, 463, 464.

*No. XIV in Allegheny County**.

In this county *south* of the Ohio river these rocks outcrop along every one of the principal streams east of the Chartiers Valley and Panhandle railroads and through five-sixths of the territory west of Chartiers creek. North of the Ohio and Allegheny rivers however, their presence is the rule, not the exception, and merely patches of the *Upper Productive* (Monongahela) *series* cap the highest summits.

In south Allegheny the Barren Measures are exposed along the Ohio as far as Rochester; but at few places are more than two-thirds of the group above water level as the overlying Pittsburgh coal, 360′ above the river at Pitts-

PLATE 473

N° XIV Pittsburgh Series in S.W Penn.a

GENERALISED SECTIONS OF THE LOWER BARREN MEASURES IN BEAVER, ALLEGHENY, WESTMORELAND AND FAYETTE COUNTIES.

BEAVER COUNTY
(J.C. White.)
ALLEGHENY COUNTY
(J.C. White.)
PITTSBURGH COAL BED.
WESTMORELAND COUNTY.
(J.J. Stevenson.)
DUNBAR CREEK, FAYETTE CO.
(J.J. Stevenson.)
PITTSBURGH COAL BED.
Conemaugh Limestone & Shale
Conemaugh Limestone & Shale
Conemaugh Limestone & Shale



sity of topography their decomposition gives rise to. The series of four vertical sections of plate 473 will serve to show the character of this group in the south-west corner of the State. The series holds four conspicuous sandstone members; the *Connellsville sandstone*, with an average interval of 50′ beneath the Pittsburgh coal; the *Morgantown sandstone* 100′ lower; the *Saltsburg sandstone* 350′ beneath the Pittsburgh seam and finally the *Mahoning sandstone* at the base. But all these sandstones, while persistent as a whole, thicken and thin and pass into shales, so that they cease to become stable geological guides as key-rocks over wide areas.

The *limestones* of the Barren Measures in this county occur chiefly near the top; they are thin and commercially worthless, though two of them are important key-rocks, invaluable in a series so bereft of other persistent and well recognized rocks. These are the *Crinoidal limestone* at 250′ to 300′ beneath the Pittsburgh coal and the *Black limestone* about 100′ above the Mahoning sandstone.

The *Pittsburgh limestone** is a fairly persistent bed, which occurs a few inches to 8′ beneath the Pittsburgh coal. It is a coarse, brecciated limestone, light blue to gray in color.

The *Crinoidal* (Green Fossiliferous of the First Survey) *limestone* is only 2′ to 4′ thick, but always so filled with multitudes of crinoidal disks, spines and shells that it is readily recognized. It has usually a dark greenish gray color, tough and breaks with a granular surface. Along the Ohio river, it is present and constantly in sight from Nimick's station to Birmingham, but differs greatly from its usual appearance. It is of irregular thickness, sometimes embedded in a calcareous shale, extremely rich in fossils, while at other places forming a rude shapeless mass of limestone 6′ to 8′ thick. Going up the Monongahela it soon resumes its natural condition and is so exposed

* Below this 10′ to 30′ there is another quite persistent limestone distinct in Westmoreland and Fayette, but absent in north-west Washington and western Allegheny.

at Six mile ferry, Braddocks and Peters creek, where it passes beneath water level, and is not noted to the south. The coal beds of the series amount to nothing; but thin and worthless as they are, they seem to occupy regular positions in the column of rocks (see plate 474.)

The *Little Pittsburgh coal* can be frequently seen along the Monongahela river south of Port Perry and near Mansfield, 15′ to 20′ beneath the Pittsburgh coal. The *Barton* (Elk Lick) *coal* is locally present in north-western Allegheny, beneath the Morgantown sandstone and 100′ below the Little Pittsburgh coal. Other more or less sporodic coal beds are present in the interval 150′ beneath the Crinoidal limestone.

The *Barren Measures** also contain a conspicuous deposit of red, varigated and bluish sandy shales 100′ thick, beneath the Morgantown sandstone, especially noticeable around Pittsburgh. Three red shale horizons are frequently noticed; one 100′ beneath the Pittsburgh coal; another beneath the Crinoidal limestone; a third above the Mahoning sandstone.†

The general section (plate 473) shows at a glance the number, character and interval between these Barren Measure rocks.

The *upper Pittsburgh limestone* is seen at several localities; quite compact; conchoidal fracture; slacks to a beautiful white lime. The *lower Pittsburgh limestone* is

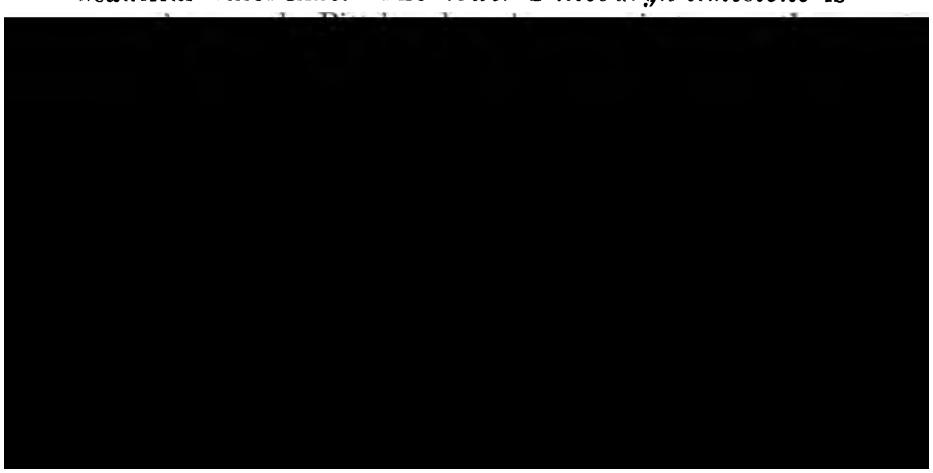
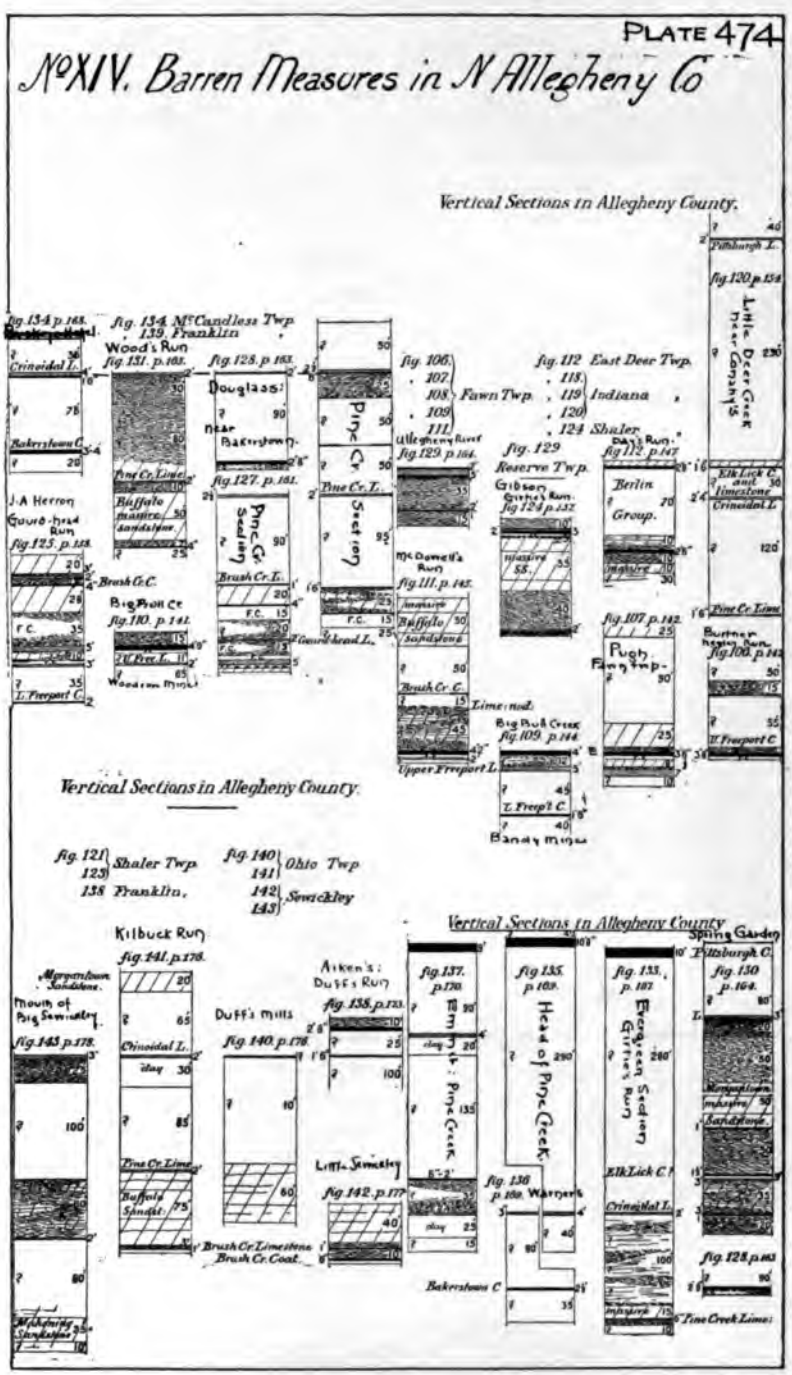


PLATE 474

No XIV. Barren Measures in N Allegheny Co





layers; dark gray color; containing considerable iron. The red shale band beneath it is a constant companion. The *Morgantown sandstone** is very constant, 180′ below the Pittsburgh coal; extensively quarried north-west of Allegheny city for building purposes, firm and compact, some layers coarse and conglomeratic. It makes a long line of cliffs on the Ohio near mouth of Killbuck run (see section here: plate 474 fig. 141.)

The *Elk Lick coal*,† in this district is about 275′ beneath the Pittsburgh coal and about 30′ to 40′ above the Crinoidal limestone; but is not persistent and is subject to many variations. The *Elk Lick limestone* is local in occurrence; at some points a calcareous shale soon thickening up to 6′ of irregular limestone.

The *Green Crinoidal limestone* is the most persistent member of the group and found about midway between the Pittsburgh coal and Upper Freeport coal, everywhere characterized by lithological and palaeontological features.‡ The *Platt coal* beneath it never attains workable thickness and is frequently absent. The red clay shale beneath it covers large areas in north Allegheny. The *Bakerstown coal*, 400′ beneath the Pittsburgh coal, has been mined largely at Bakerstown, Richland twp., though very irregular; about 2′ 8″ thick with three very thick partings, and inferior coal, and showing 6″ of cannel at the bottom. It is here 90′ below the Crinoidal limestone. The *Pine Creek limestone*, 50′ below, is somewhat persistent, especially on Pine creek; sometimes a compact dove colored

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*This is the highest member of the series found in Butler Co., all the upper portion of the group having suffered erosion.

† Head of Duff's run it shows top cannel 8″; slate 1″; coal 2′. At Allegheny City it is cannel slate 1′ to 2′ thick generally, and on Butchers run a bituminous coal. Head of Pine creek 2′ thick; head of Hites run 3′ to 3½′, and excellent coal, but on neighboring farms it is not found at all.

‡ Rough surface when weathered and containing: *Athyris subtilita*, *Productus Nebrascensis*, *P. semi-reticulatus*, *Spirifer cameratus*, *Nucula ventricosa*, *Bellerophon carbonarius*, *Pleurotomaria Grayvilliensis*, *Astartella concentrica*, and numerous undetermined species.

rock but generally arenaceous. It is always fossiliferous* and more or less brecciated.

The *Buffalo*† (Upper Mahoning) *sandstone*, 450′ to 510′ below the Pittsburgh coal is best developed in Butler Co.; traced south into Allegheny it looses its conglomerate character, and is well seen along the railroad from Allegheny City to Hayesville.

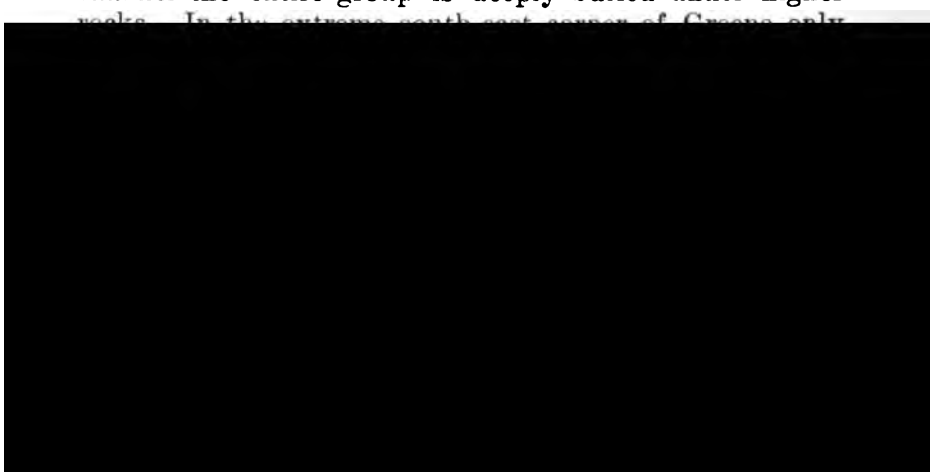
The *Brush Creek* (Philson) *limestone*‡ is another persistent stratum, though variable in section; and beneath it 10′ to 15′ is the *Brush Creek* (Gallitzin) *coal* (No. VII of the Ohio Survey).

The *Mahoning lower sandstone*, at some localities, is a massive rock 75′ thick; again it is a mass of shales (see plate 474.) Where massive, it is a coarse grained yellowish white rock, largely used for building purposes.

No. XIV in Greene and Washington Counties.

This series consists chiefly of sandstone and shales with some variable limestones and coal beds. Along the Monongahela river the upper portion is exposed to the West Virginia line as well as along the whole river front in Washington and Allegheny Cos.

The extreme thickness exposed along the Monongahela is 375′, and this only near the West Virginia line and at Pittsburgh. Throughout both counties away from the river channel the entire group is deeply buried under higher



limestones, one immediately below the coal and the other 15′ lower.*

The *Pittsburgh limestone* beneath the coal is coarse, light blue to gray and contains a large number of minute univalve mollusks. At 10′ to 30′ beneath this there is another limestone, persistent in the south-east, where it becomes 12′ to 14′ thick.

The *Little Pittsburgh coal* rests on this limestone and is persistent as far north as Chartiers creek in Washington and Mansfield in Allegheny Co. It seldom exceeds 18″.

The *Morgantown sandstone* is widespread, 140′ to 160′ below the Pittsburgh coal, though variable. It is 52′ thick opposite Pittsburgh and further up the Monongahela forms cliffs. In south-east Greene Co. it is 30′ to 70′ and is the *first oil sand horizon* along Dunkard creek. It is blue gray in color, coarse grained and makes an excellent building stone. The geological maps of these two counties graphically display the extremely limited outcrop of the Barren Measures, in Greene confined to strips along the Monongahela river south of Greensboro and in Washington to the river banks; to a small area along Chartiers creek over the Washington axis and to a more extensive area in the north-west corner of the county north of the Panhandle R. R.

*The changes are so great and the measures of so little economic value that they hardly demand detailed description for which the reader is referred to Report K. Some of them however are persistent and preserve their characteristics to some extent.

CHAPTER CXXV.

*No. XV. The Upper Productive or Monongahela River Series.**

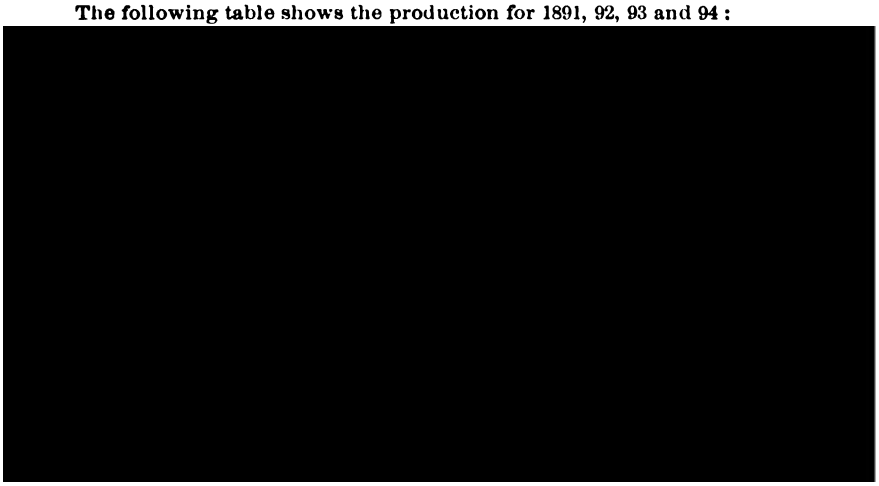
The *Upper Productive* or *Monongahela River Series* (No. XV) is the next succeeding group upwards, with the *Pittsburgh coal* on the bottom and the *Waynesburg coal* on top; a series of six coals (four of which are workable), shales and thick limestones, averaging 375′ to 400′ thick along the Monongahela river, and confined largely to the south-western corner of the State in Allegheny, Washington, Greene, Westmoreland and Fayette Cos,† with small outlying

*See reports K, K 2, K 3, Q, H 4, H 5, L. and Annual Reports for 1885 and 1886, Pennsylvania Geological Survey, for all details in the entire Pittsburgh Region.

†The total bituminous coal area of Pennsylvania has been estimated (Min. Res. United States) at 12,222 sq. miles; Broad Top 80 sq. miles; Anthracite 468¼ sq. miles. Total production of bituminous coal in 1880 was 19 million gross tons, of which Allegheny Co. furnished 4,426,871 tons; Westmoreland 3,297,391 tons; and Fayette 2,318,728 tons.

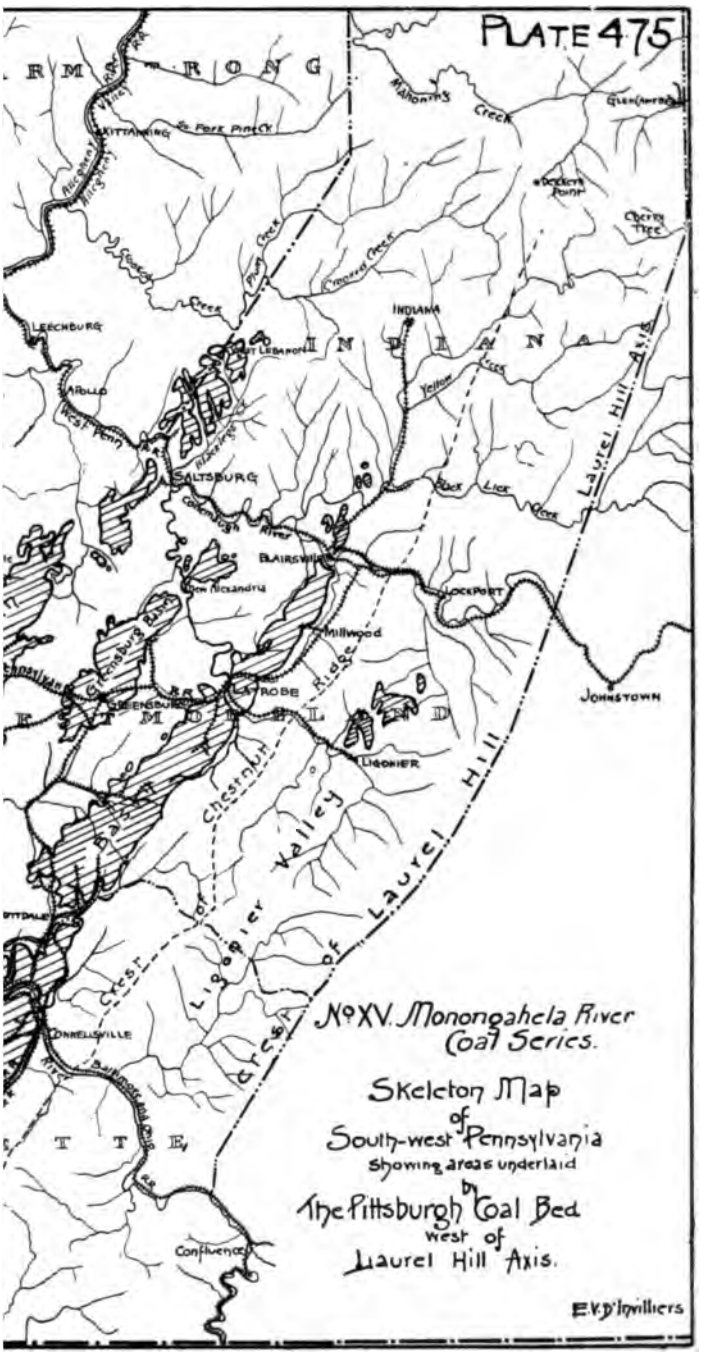
Total production in 1890 was 42,302,173 short tons and the same three counties produced respectively 4,894,372; 8,290,504 and 6,413,081 tons, showing clearly that while Allegheny Co. maintained her average, Westmoreland and Fayette greatly increased their output, due in large measure to the rapid development of their unexcelled gas and coking coal fields.

The following table shows the production for 1891, 92, 93 and 94:




BUTLER
BEAVER
Rochester
Ohio River
Beaver River
Connoquenessing Creek
Big Sewickley Creek
SEWICKLEY
Penn
Imperial
PITTSBURGH
Chartiers Creek
Peters Creek
Peters Creek
Cross Creek
CANONSBURG
WASHINGTON
Whegling Div.

[redacted]


PLATE 475
ARMSTRONG
INDIANA
WESTMORELAND
FAYETTE
Kittanning
So. Fork Pine Ck.
Allegheny River
Allegheny Mountains
Mahoning Creek
Glen Campbell
Rockey Point
Cherry Tree
Pine Creek
Crooked Creek
Plum Creek
Leechburg
Apollo
West Penn
Saltsburg
Conemaugh River
Blairsville
Yellow Creek
Two Lick Creek
Laurel Hill Axis
Lockport
Johnstown
Millwood
Chestnut Ridge
Latrobe
Greensburg
Ligonier
Ligonier Valley
Crest of Laurel Hill
Connellsville
Youghiogheny River
Monongahela River
Confluence
No XV. Monongahela River Coal Series.
Skelcton Map of South-west Pennsylvania showing areas underlaid by The Pittsburgh Coal Bed west of Laurel Hill Axis.
E.V.d'Invilliers



patches in Indiana and Somerset Cos. (general sections plate 507.)

A group of the richest coals and limestones,* doubly so by contrast with the *Barren Measures* above and below, its numberless interesting features are overshadowed and lost sight of in the presence of the wonderful and unique *Pittsburgh coal bed* at its base, whose outspread in S. W. Pennsylvania is delineated on plate 475. A chapter the length of this entire article might be readily appropriated to this peerless seam of coal without hall exhausting its points of interest; and no more cogent paragraphs have been written of it than these by the distinguished Director of the Second Survey‡, from which the following extracts are taken:

"The *Pittsburgh region* has an outspread of the *Pittsburgh coal* bed 50 miles long by 50 miles wide within the limits of the State. In the north-western part of this area the bed is 2′ or 3′ thick, increasing in thickness eastward and southward to 6′ of good coal at Pittsburgh, 10′ up the Monongahela, and 12′ up the Youghiogheny. What the thickness of the bed may be underneath the uplands of Washington and Greene Cos. we now know by the new gas

*"The character of the rocks interstratified with the coal beds changes greatly in passing from the *Monongahela river* southward to the *Great Kanawha*. At the northern end of the basin in Marion, Monongalia, Greene, Washington, Fayette and Westmoreland Cos., limestone forms about one-half of the rock material, and the same is true on the western side in Brooke, Ohio, Marshall and Belmont Cos. Red shale is unknown in the series at the north, but in passing southward from Harrison and Lewis Cos. the limestones practically disappear, and with them all of the coals except the *Pittsburgh*. With their disappearance red shales come in and apparently replace the limestones, so that on the Great Kanawha nearly one-fourth of the rock material in this series is red shale, while the thickness is reduced to 270′. Along with this change in the character of the rocks there occurs a great change in the topography made by these beds: for at the north, where limestone is abundant, sandstones are few and shaly, so that a gentle, rolling topography results, with a very rich soil and one of the finest grazing and farming regions in the country; while to the southwest, after the limestones have disappeared, the sandstones thicken up and become more massive, thus giving rugged and precipitous slopes with narrow valleys." I. C. White, Bull. 65, U. S. G. S.

‡The *Geology of the Pittsburgh Coal Region:* J. P. Lesley. Transactions of the American Institute of Mining Engineers. Pittsburgh meeting: February, 1886.

wells. It maintains its thickness in that direction. An average of 8′ for the whole region looks like a fair one. This gives 8,000,000 tons to the square mile, and there are 2,500 square miles. Allowing one-half of the area to be interval, separating outcrops, we have 10,000,000 tons remaining in this one coal bed. Allowing 50% for pillars, bad mining and waste of all kinds, we may set down its coal available for market in the future at 5,000,000,000 tons."

"The Pittsburgh region, at least, has no reason to complain of the laws of nature; for it has escaped while other regions have suffered. The splendid mineral wealth of this district depends 1st, on the superior quality of the coal which has been preserved; 2nd, on the almost unlimited quality of it within easy reach; and 3rd, on the exceptional facilities offered by the geological structure to mining operations; but not upon the size of the individual coal beds."

"The quality of the coal of the Pittsburgh region, especially of the *Pittsburgh bed*, is A No. 1 in the scale of merchantable coals of the world. The prime factors in this quality are: 1. The low percentage of ash. 2. The small amount of pyrites. 3. The excellence of the coke made from it. The ash varies between 3% and 5%, and seldom exceeds 6%. The sulphur in analyses ranges at below 1% rising however occasionally to 2% or 3% in hard specimens. The coal contains from 30% to 35% of volatile matter. When coked, allowing for waste, something over one-half its weight remains as a silvery, ringing, tough, and pure coke, preferable to any coke made from the coals of the Southern and Western states, chiefly on account of the absence of sulphur, but partly on account of some obscurely understood internal constitution of the coke, giving that special hardness adapted for holding up the burden in a high stack

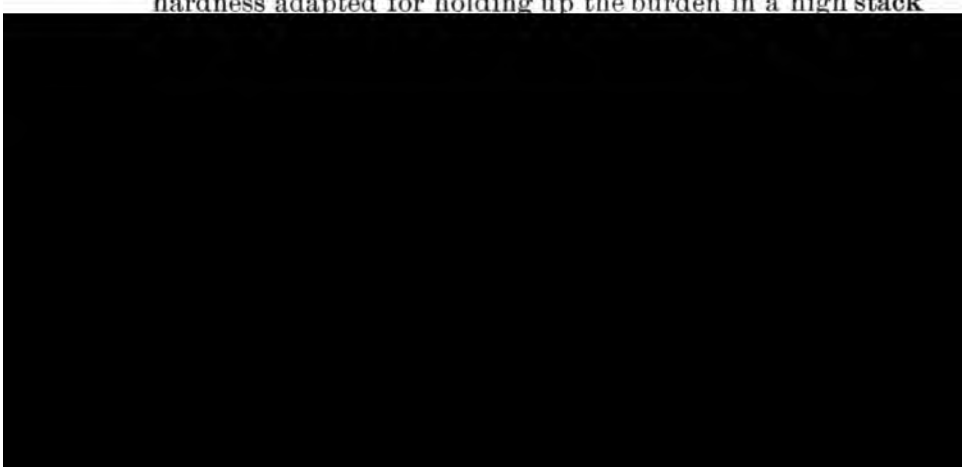




Plate No 1.

Plate 476.

Fish remains found in uppermost 2½ inches of the "Breast Coal Bench" Pittsburgh Coal Grant Mine Monessen Pa

Reference to Plate I.

No. 1. ? Teeth or bone (fragment).
" 2. ? Fish scale (upper part 1/32" thick) somewhat of dark brown horn-like substance.
" 3. Fish scale, with seven spines.
" 4. Scale, probably.
" 5. " "
" 6. " (thick in centre)
" 7. "
" 8. "

No. 1 to 8 all on same bedding plane within 3 inches of one another, yet all detached. Many other more broken fragments and shell like bits scattered over within same area.

Exact horizon of these is 3/8" below top of "breast coal" at Grant Mine.

No. 9. ? Bone or scale.
" 10. Five scales - elliptical, brownish amber color and semi-transparent.
" 11. Fragments of a ? scale.
" 12. ? Scale.
" 13. ? Spinous scale.
" 14. Fract. of ribbed scale or skin.
" 15. Fish scale.
" 16. ? Sculptured ? scale

On same bit of coal.

No. 17. ? Fin.
" 18. Bit of ? spinous scale with numerous (8 on 3 rings) groups of fine heavy very
" 19. ? Swartzia tooth (in gray coal)
" 20. ? Fish spines or teeth (some
" 21. " marine per's jaw?)
" 22. Teeth of fish.
" 23. Bone of ? "
" 24. ? Bit of a fish or saurian.
" 25. ? Scale.
" 26. ? Scale of saurian . . . . . .
" 27. Fragment of skin of fish or reil.
" 28. . . . . .
" 29. ? Bone (comp. No. 7 Plate II)
" 30. ? Bit of skin of . . . . . .
" 31. Scale.
" 32. Bone.
" 33. Bone or scale.
" 34. ? Scale.
" 35. Bone of . . . . . .
" 36. ? Spinous associated with the
" 37. fish & s. remains.
" 38. Scale of ?

W.S. Greeley Eng. Pa



sin and finally a hard, cubical, rich, domestic coal all along the Monongahela river and to the Ohio line.

The *Upper Productive* or *Monongahela River Series* contains four other persistent coal beds*, but none of them as persistent as the Pittsburgh bed as to quality, availability or thickness. The order of the beds, first established in 1840, has remained unchanged down to the present time; but their variations have been noted, their sections revised and their individual characteristics more minutely studied and reported upon by the Second Geological Survey.

The *Waynesburg coal* is now generally regarded as the top of the Productive Measures; 100′ lower comes the *Uniontown coal;* 150′ still lower the *Sewickley*; then the *Redstone* 50′ down, and finally the *Pittsburgh*, 60′ below, at the base. The names are assigned from the districts in in which they reach their maximum size and best quality, each bed in its special area ranging from 3′ to 5′ in thickness and furnishing good coal, but elsewhere dwindling to 2′ or 2½′, and only worked for local farm use. But the overwhelming predominence in value of the *Pittsburgh coal* renders it practically the only commercial bed of the region, and it is the only one mined for the general trade; so that there remains much to be learned in detail concerning the other four upper beds of the Series.

The great feature of the *Upper Productive Coal Measure Series* is its limestone rocks. Of these the "*Great Limestone*," occurring between the Sewickley and Uniontown coal beds, is the most conspicuous. It is a triple deposit; an upper limestone and shale, 20′ thick; a middle sandy and shaly mass, 60′ thick; and a lower limestone and shale, 50′ to 60′ thick.

Between the Sewickley and Redstone coals the *Fishpot limestone* is sometimes 20′ thick; and between the Redstone and Pittsburgh beds there is still another limestone which becomes 10′ thick. Hence nearly one-fourth of the

*See Vertical Sections in different parts of district; plates 488, 492, 494, 507, 527 and 528.

rock interval of this group is composed of limestone in Pennsylvania.

One other feature of special interest might be mentioned in connection with the characteristics of the *Monongahela River Series* i. e., the occurrence of the Plant bed *over* the Waynesburg coal and *under* the Waynesburg sandstone, made classical by the elaborate report of Messrs. Fontaine and White.*

The *Uniontown coal* is sometimes a bed of cannel shale containing great numbers of fish teeth and scales, which have also been found in great abundance in the *Pittsburgh coal* at Mansfield, Penna.† and illustrated by drawings of Mr. W. S. Gresley of Erie, Pa.

In the structure of the region a vast number of secondary anticlinals and synclicals have been discovered and located during the progress of the Second Survey, the First Survey having laid down only five great axes in western Pennsylvania. These axes have been made to play an important role in the location of gas wells during the last 20 years; but the theory that all great wells are associated with such structural lines has many opponents and is hardly maintained by the records of the drill in recent years.

The *Waynesburg coal*, the highest member of the series, is generally quite persistent in south-west Pennsylvania;‡ but it is eroded from all the eastern outlying areas in Som-

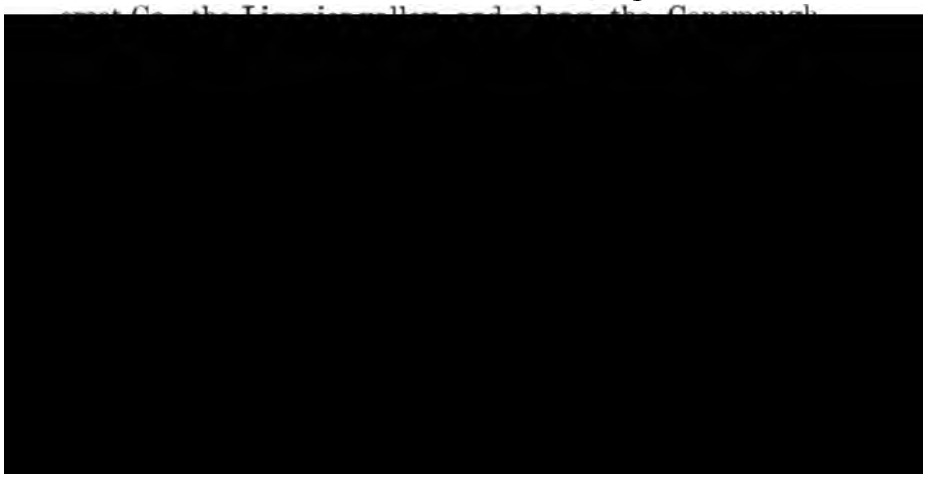


PLATE 477

Fish remains etc. found in uppermost 25 inches of Brush Coal Bench, Pittsburgh Coal Grant Mine Mansfield Allegheny Co Pa.



Reference to Plate II.

No. 1. Fish teeth.
" 2. " " "
" 3. ? Spine or tooth.
" 4. ? Tooth or spine, and bone (? of Selenichia).
" 5. Fish teeth - split down centre.
" 6. ? Carapace - ? Scale - ?Bone.
" 7. ? Bone.
" 8. Fish scale.
" 9. " -teeth.
" 10. Tooth of ? Ichthosaurian.
" 11. " " " (in heated cannel)
" 12. ? Cranial bone of ? Ichthyosaurian.
" 13. Fish Scales. (On same plane with it are fern leaves of ? Sphenopteris and ? Pecopteris.
" 14. ? Scale.
" 15. ? "
" 16. ? Ornamented or sculptured bone or Scale, not unlike Holoptychius.
" 17. Tooth of fish.
No. 18. Tooth of ? Fish.
" 19. ?Suture of ? reptile.
" 20. ? Skin or scale of fish like saurian.
" 21. Teeth of Fish, and Macrospore.
" 22. Fragment of a?Carapace of ? Phillopod.
" 23. Anthracosia.
" 24. Tooth of ? Saurian or ? fish.
" 25. ? Scales of ?
" 26. Spirorbis ? carbonarius.
" 27. Teeth of . . . and ? Entomostraca
" 28. ? Rib of Saurian.
" 29.
" 30.
" 31. Entomostraca.
" 32.
" 33.
" 34. Triradiate macrospore.

W S Gresley Erie Pa



often 10′ thick, separated into three layers, the upper division of slate very fossiliferous. It yields a hard coal, mining out in blocks, but frequently ruined by large percentages of ash and sulphur; but it has local importance and use.

The bed shows thickest and best in that portion of the district through which the Monongahela river and its western affluents now flow, especially in the eastern townships of Greene Co., the western border of Fayette, the southwest part of Washington and the northern border of Virginia, over which central area the coal bed has a very variable thickness from 5′ to 10′, of which a fourth, third and sometimes a half consists of one, two, three or many partings of clay. In all directions from this area of mining thickness the bed degenerates and becomes too thin to be of any value. Its mining region is therefore confined mainly to Dunkard, Greene, Monongahela, Cumberland, Jefferson, Morgan, Franklin and Perry twps. of Greene Co.;* German, Brownsville and Redstone twps. of Fayette; and East Bethlehem and Pike Run of Washington,† but it is somewhat mined on the Wheeling Creek waters; at various places in middle Washington Co.; a little in Jefferson twp. of Fayette;‡ and in Rostraver and South Huntingdon twp. of Westmoreland, where the coal is excellent, but the bed only 3′ thick,§

Vertical sections of this coal in Greene, Washington and Fayette counties, over region of best development, are given in plates 479 and 480.

In structure the bed varies greatly. ‖ Its parting clays

---

* In central Greene Co. it is deeply buried, in some places 1200′.

† Here it is in places 6′, 7′ and even 8′ thick; but in the northern and western townships it is thin and poor.

‡ In Washington and Menallen twps. it is too thin to encourage mining.

§ In North Huntingdon it is quite worthless. In the *Blairsville basin* even whilst 4′ thick, in Mt. Pleasant and Unity twps., its coal is too poor to work and the patches are small. Further south in the *Connellsville basin* the bed is only 2′ thick, and is overshadowed by the great Connellsville coking seam.

‖ In *Pinkook district*, Washington Co., as at Pleasant Valley, three

expand at the expense of the coal benches, usually cutting into the thickness of the overlying layer. Of its quality, as determined by eight analyses from different areas, it may be said to contain one-half carbon; one-third gas; 11% to 16% ash; 1.2% to 3.7% sulphur and only one or two per cent. water. The various vertical sections of this bed in plates just referred to are typical; but no series can sufficiently indicate the infinite number of variations the bed is subject to, there being frequently a half dozen different measurements possible in a single mine.

Above the coal there is a variable shale 0′ to 12′ thick, somewhat sandy, to which importance attaches as having vast numbers of plant impressions,* characteristic of the horizon in south-west Pennsylvania as well as in West Virginia over an area of several thousand square miles.

The *Little Waynesburg coal*, 25′ to 40′ below the main coal, seldom exceeds 1′ in thickness, and is often a mere streak, rarely seen south of the Pennsylvania line.

The *Waynesburg limestone* immediately underlies this thin coal; dark gray in color; seldom less than 8′ and sometimes double that thickness, and several layers making a good agricultural lime.

The *Uniontown sandstone* is the next member of the group, sometimes entirely filling the interval between the Waynesburg and Uniontown coals, and displacing the local limestone just described. It is well exposed at Bobtown in



A TYPICAL COLUMNAR SECTION

(Taken in Detail)

OF THE

"PITTSBURCH" COAL-BED

in Allegheny Co. Pa.

GIVING THE RECOGNIZED FOSSILS, INCLUDED MINERALS, &c.

As observed by W. P. Gresley ME. FGS. &c.
Civil Engr.
1875.

DESCRIPTION OF STRATIFICATION.	SECTION	Scale 1 Foot	FOSSILS &c.
Coal			
Shale dark gray and mottled, richly laminar, small streaks of coaly material			Reed like plant remains Rods. Leaf scars Bits of wood tissue & Fish teeth and scales
Coal, bright and black, clean fracture Very thin partings of shale here & there			
Shale Dark gray Coal, Bright and characteristic, some films of mother of coal			Individual leaves &c. Fern leaf Bundles of Rods
Coal coarse Fire clay or shale mottled coaly streaks Coal Bright & good Clod of coal & c. S.C. same as below Distinct parting below coal			Ferns Calamites Sigillaria &c Rods of coal Spheroids Pyrite Calamites Sigillaria
Fire clay, impure, brownish gray with local tendency to mottling and veining. Many irregular joints. Close texture, fine grained. Yellow clay in joints			Rods Mother coal & Algæ
Many queer-looking curved and wriggly forms composed of glossy black coal, apparently plants grown in situ. Many of these extend upwards from the coal below. Many extend horizontally to unknown lengths, and their cross-sections change shapes irregularly. Smooth externors with film of clay adhering to their coaly forms.			

PLATE 478



The *Uniontown coal bed*, immediately beneath this sandstone, underlies the Waynesburg coal from 80′ to 100′, but is only of economic importance in Fayette and Washington Cos. Seldom over 3′ thick, it often contains a clay or slate parting near centre, 4″ to 6″ thick, and carries a high ash. Still it is persistent as a coal or bituminous shale and has been noted as far east as the *Salisbury basin* of Somerset Co., where it is over 3′ thick, and still holds its slate parting. When existing as a bituminous shale it contains great numbers of fish teeth and scales, found in abundance near Davistown, Greene Co.

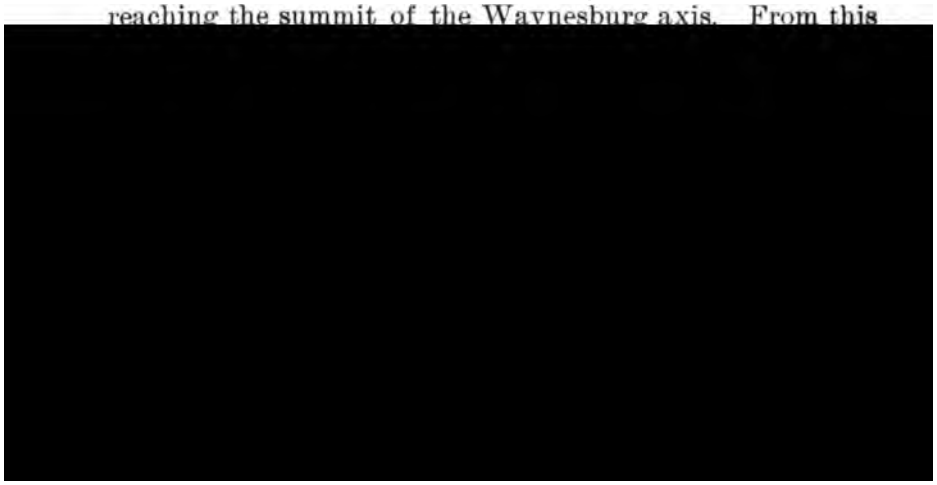
The *Uniontown limestone* underlies this coal, and is regarded as the upper member of the "Great Limestone," a term applied to the double mass of limestone and separating shale, coming in between the Uniontown and Sewickley coal beds. This upper division is usually 10′ to 15′ thick; frequently impure and buff colored, but often a good cement rock, as at Uniontown, Fayette Co. It has been found 12′ to 15′ thick in the Salisbury basin of Somerset Co., 160′ above the Pittsburgh coal.

It disappears towards Pittsburgh and is absent in Allegheny Co. and Ohio. The lower division is everywhere found, except in north east Allegheny Co., and is 50′ to 90′, the two divisions and intermediate sandy shale often reaching 160′ in thickness. The character of the lower division varies greatly in the Pittsburgh region. The lower portion is commonly more magnesian, frequently a cement rock, and available throughout eastern Washington. It is also the more persistent part of this division; but the relative proportion of shale increases northward and in Allegheny Co. shales predominate. It is wholly non-fossiliferous. The upper part of this division contains every variety of limestone; some fossiliferous layers, mostly *univalves*, while at the very base *Lamellibranchs* predominate.

The *Sewickley coal* comes next in Pennsylvania, widely persistent, but economically valuable over a comparatively small area. It attains its maximum importance and thickness along the Monongahela river in Greene Co., and even

better in West Virginia, being 5′ to 6′ thick with only one 2″ or 3″ parting near the centre. This bed contains a higher percentage of sulphur and ash than the Pittsburgh coal; but it is open burning and makes a good domestic fuel for house and grate purposes. Towards the north it turns into a bituminous shale and is absent in Allegheny Co. Best in West Virginia, its slate partings thicken up in reaching Whitely creek in Greene Co. and new ones enter, to spread the coal in several layers through 25′ of rock material, though usually in three divisions.*

Along Ten Mile creek it is 12″ to 22″ thick; thin shale further north, but at Brownsville 4′ 4″ with 2″ of clay 8″ above floor. It shows also along Chartiers and Cross creeks in Washington and on the Panhandle R. R., but usually as a bituminous shale. In *Fayette Co.* it swells up again to 4′ or 5′ in several townships, only to thin out and lose its importance northward in *Westmoreland Co.* It is scarcely known in the *Ligonier basin*, but is 2′ thick at *Salisbury* and 90′ above the Pittsburgh coal. The interval between the Sewickley and Redstone coals is largely occupied by two beds of sandstone separated by a bed of limestone; the *Sewickley* or *Fishpot limestone.* It is not persistent in Allegheny or Butler, and in Greene and Washington it varies greatly. Thin at the West Virginia line, it increases to the mouth of Fishpot run where it is 30′ thick. From here it diminishes and at length disappears before reaching the summit of the Waynesburg axis. From this





Contained a boulder like mass of hard yellow limestone in a mine at Stott Haven.

Fire clay gets much darker at base and gradually changes into coaly material.
Coal, heavy, hard, dull black earthy & bony
lenses of brown & mottled shale; eyes of dull coal, very numerous irregular veins and queer streaks of glossy brittle coal
Coal, uniformly shattered and grained of characteristic bituminous coal texture & fracture, evenly jointed with parallel cleat running N.W. and S.E. some mother coal

Coal beautifully bright glossy black with characteristically laminated and uniformly deformed with regular cleat.
Coal rather duller and more streaky

Coal, of A No1 appearance patches of mother coal

Coal, a layer of hard dull bony nature
Coal, excellent appearance & of even structure &
Strong layer of markedly laminated, and evenly bedded or accumulated coal, getting rather wavy or irregular at base
Pitchy lustrous band of coal.
Horizontal streaks of dull & brilliant coal
Pitchy, lustrous layer
Dullish compact layer, very closely laminated
Closely laminated coal of even texture
Bands of brilliant coal separated by thin dull lines

Dullish laminated coal, grading into
Brighter layers, with flakes of mother coal
Very fine, compact, glossy black pitchy coal possessing all the excellent characteristics

Parallel laminations of bright and duller layers.
Streaky coal, hard and compact.
Compact stout, even-grained fine coal

Softish lamina of bright & duller coal

Pitchlike layer of brilliant coal
Harder & less brilliant layer
Bright pitchy layer of coal
Band, composed of stout interlaminations of duller & brighter streaks of coal

Compact, bright hydrocarbonaceous layer of excellent coal. Some flakes of mother coal

Parting with mother coal
Interlaminations of dull & brilliant coal.
Layer of splendid bright compact coal with mother coal here and there
Somewhat irregularly bedded layer.

Typically laminated, excellent stout coal with a few dullish pitchy patches

Streaks of duller coal in pitchy lustrous layers
Band of pitchy lustrous coal of considerable thickness without any dull streaks

Excellent typical coal in every particular; contains a few lenticles of pyrites and very fibrous patches

small scales of selenite

*Productus, ? Spirifer
Beyrichia, Spirorbis
Numerous remains of fish & of Microsaurians & Batrachians. Macrospores &c.
Fern leaves. Anthracosia &c.

Lepidodendron
Marcasite in mammilated and radiate forms in open joints.

Pyrite, in scales
Amber bits.

"Roots" in mother coal

Many leaves of Ferns.

Selenite and a white powder on vertical joints
Ferns
"Roots" Distinct mat tissue of different kinds
"Roots" and Fern leaves
Macrospores & their dust
Fern leaves
Crystals of Selenite in scales on vertical joints

Fern leaves

"Roots"

PLATE 478A



only, and west of the *Claysville axis* as far north as the Steubenville pike.

The *Redstone coal* occurs next, found along Redstone creek in Fayette, 40′ to 45′ above the Pittsburgh coal, and though exceedingly variable, is everywhere persistent as coal or shale.* It is present all along the Monongahela; in northwest Washington; central Allegheny along the Panhandle, and along nearly all the stream valleys. It is workable in several townships of Fayette and Westmoreland Cos., and 3′ to 4′ thick. In the Salisbury basin it is also 4′ thick, but slaty, 45′ above the Pittsburgh coal. In Allegheny Co. it gets high in the hills and is poorly exposed, and except in the southeast corner, it is poor, varying from 2″ to 1′.

The *Redstone limestone*, under the coal, occurs along the river in all the four bordering counties, sometimes 10′ or 12′ thick. In the Salisbury basin it is a remarkable deposit; 10′ thick at the Beachy quarry at the south end of the coal field, and yet it cannot be found in the neighborhood nor anywhere else in the whole basin, except at one spot about a mile south of Mechanicsburg. It often contains several layers, which make a fairly good lime for many purposes.

The *Pittsburgh limestone* overlies the coal, usually as a sandy slate, where the Redstone limestone is well developed, but often as a coarse sandstone when it is absent. It varies from 25′ up to 70′ and is usually friable and often pebbly, but yields readily to weathering.

The *Pittsburgh coal bed*, at the base of the series, is by far the most important, the most persistent and the most remarkable mineral deposit of the Appalachian coal field. In Pennsylvania no horizon is met with where this coal is absent or not workable. Even where deeply buried in

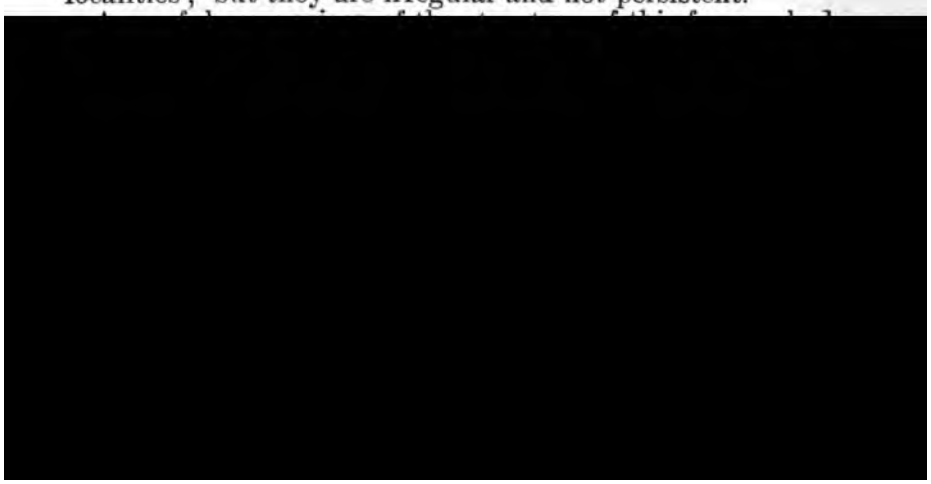
* On Dunkard creek Greene Co. bituminous shale 1′ thick; Greensboro, coal 18″, embedded in shale 13′ thick, diminishing to Whitely creek, where the shale disappears. Near Hatfields ferry the coal goes under the river, appearing at Ten Mile creek as bituminous shale 18″ thick. Near Fredericktown it consists of 3′ bituminous shale and 6″ coal, and thence to Monongahela City it is a shale 1′ to 5′ thick; but coal at this latter point 3′ 6″ and continuing as such to beyond the Allegheny Co. line.

central Washington and Greene Cos., the drill has tested its presence and integrity where covered up by over 1000′ of higher Upper Barren Measure rocks; and it also preserves its characteristics in the outlying remnants in the Ligonier and Broad Top basins.*

The bed is almost always separated into two well defined portions, divided from each other by a *Main Clay parting;* the *Upper Division* or roof member and the *Lower Division* or bottom member; and there are often several minor divisions of slate and coal in each of these main members. The layers of coal in the roof member are not usually over 1′ to 1½′ thick, separated by slates or shale of equal thickness; in the main bench the slate divisions are mere knife edges, seldom more than 1″ thick and often less. (See typical section in Lisbon plate 497 fig. 2).

Prof. I. C. White in Bulletin 65 of the U. S. Geological Survey, thus concisely describes this bed:—

"Along the Monongahela river, two of these slates are especially constant, since they come about 2½′ to 3′ above the bottom of the bed and are 4″ to 6″ apart. They are usually known as the "*bearing-in*" slates, and are seldom more than 0½″ thick. Then 1′ to 1½′ below there is generally another thin parting of slate which runs through the bed with great persistency, dividing the lower portion into two layers known by the miners as the "*brick*" coal, and "*bottom*" coal. Of course there are other partings which occasionally make their appearance in the bed at some localities; but they are irregular and not persistent.



Rather uneven parting

Pitchy lustrous stout excellent coal with some pronounced more brittle & glossy layers also a few dull streaks and small dirty seams

Roots

Fern leaves

Reed like plant? Vermicularia
Macrospores
Sigillaria remiformis
Stenomia ferns
Spirorbis worm (eel) tracks
Pyrite Melanterite Calamites

Shale, slaty grey and often mottled, fine grained rather irregular, shades into hard coal laterally, small mother coal, and a few joints.

Very rich looking glossy black compact uniformly compressed evenly laminated typical soft coal with a 3/4" layer of pitch like coal near middle. Cleat N.W. N.E.

Sigillaria
Pattened leaves and twigs
Macrospores Melanterite
Spine like forms Pyrite

Shale, mottled or dark brownish grey. Specks & streaks of coal. Non plastic. Fracture splintery for a irregular joints. Weathers slowly.

Rich, lustrous black evenly deposited & compressed, moderately hard beautiful typical bituminous coal. Some prominent pitch like laminæ. Considerable mother coal. A few dirty fetid patches. Cleat N.W. and S.E. very regular, vertical and about a inches apart.

Pyrite in stringy veins, platy Gypsum in Colorless crystals

Rather prominent coaly parting. Uniformly accumulated & deposited rich glossy black characteristic soft coal, interspersed a few dirty finely patches are interstratified. Duller laminæ very thin. Numerous flakes of mother coal. Joints more numerous than higher up.

Fern leaves
Gypsum in thin scales
Selenite crystals
Macrospores

Brilliant brittle characteristic bituminous coal with some fine dull laminæ and films of pyrite

Bright and excellent coal with a few patchy streaks of mother coal and a little coaly material

3 kinds of Fern leaves
Alum & Melanterite

Dull laminæ in bright pitchy coal

Very uniform interstratified laminæ of brilliant and duller coal

Calamites Macrospores
Ferns Cordaites Roots

Bright rich looking characteristic coal with here and there tendency to harder duller layers. Some coaly patches

Macrospores
Calamites Cordaites

Shale, dark grey to mottled, in places much mixed with carbonaceous material. Splintery fracture. Uniformly accumulated and mineralized thinly black typical soft coal with a few dull & hard laminæ. some patches of mother coal. Joints very numerous. First laminæ of the coal lying flat upon underfloor Gypsum. Thin horizontal veins of pyrite in coal. Calcareous shale, dark brownish grey, but often mottled. Occasionally mixed with considerable vermiform forms and small patches of coaly material.

Worm tracks
Ferns Roots
Macrospores Calamites
Pyrite Selenite Gypsum

Bones, teeth &c of fish and of Mena saurians
Shavings (?) of
Entomostraca
Leaves of plants

Calcareous stratum of siliceous and aluminous materials. Hard and of irregular structure often contains many coal stock nodules.

Indistinct plant remains.

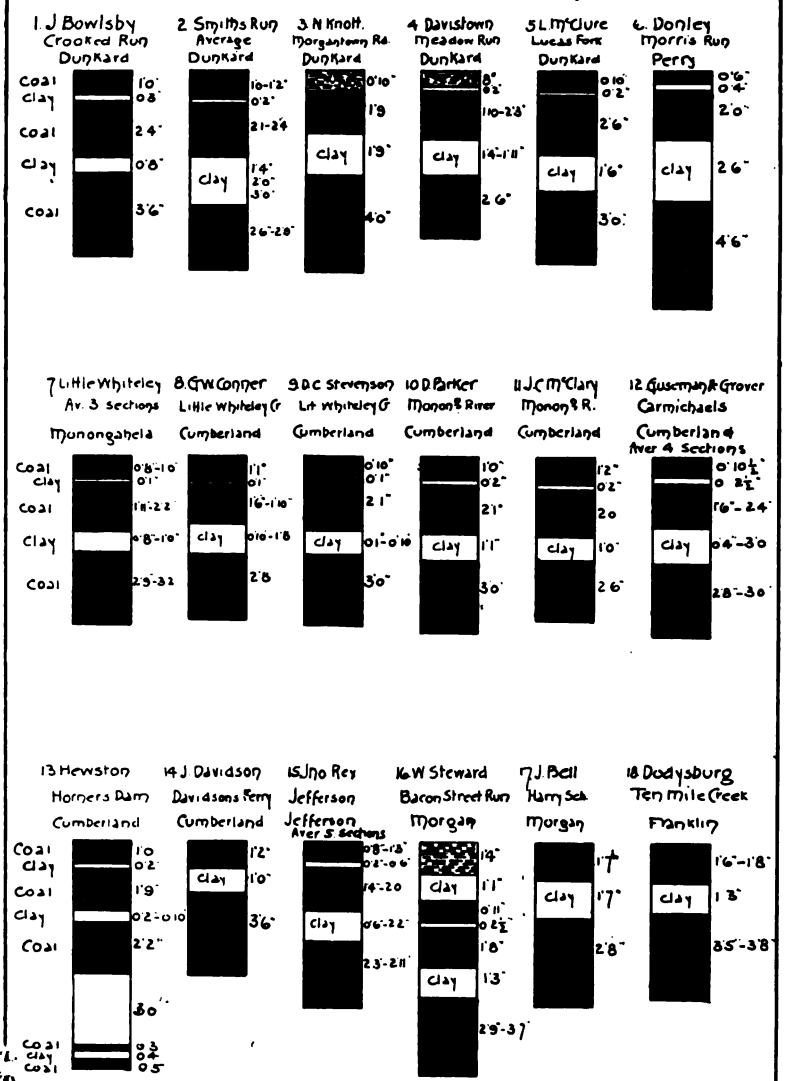
PLATE 478 B.

two small partings or "bearing-in" slates, and the next lower "brick coal" bench are usually destroyed in mining; the "lower bottom" bench beneath them is generally impure and is also partially destroyed, so that the mining output is largely obtained from the upper "breast coal," and this member varies from 3′ to 9′, and yields the best coal. Ordinarily but one clean bench, it carries a thin parting in the north-west part of the field, also quite prevalent in the Ligonier, West Lebanon and Salisbury basins. (See plates 422, 468, 469 and 470).

The *Bearing-in bench* is usually distinct and varies from 2″ to 4″ thick. The top of the *Lower Bottom bench* is often divided off by a thin parting and is called the "*Brick coal*" from its characteristic tendency (due to its cleavage planes) to break out into brick-shaped blocks of good coal, hardly inferior to the Breast coal. It is often mined. The bottom coal is inferior, broken by thin layers of clay, and is brittle and full of ash. It is rarely, if ever, taken up in the mines. The outspread of this magnificent bed in south-west Pennsylvania is best shown on plate 475 and on Bituminous Colliery map, plate II accompanying this report, where the deepest tint indicates its outcrop and occurrence in the several basins west of the Allegheny Mt.

The structure of this *Pittsburgh Region* west of Chestnut ridge is better shown on the special map of south-western Pennsylvania*, where the axes have been laid down and the variation of level in the Pittsburgh coal noted. The

No XV Monongahela River Series in Greene County.
Vertical Sections of the Waynesburg Coal.



Note The above sections of the Waynesburg Coal, fairly show its variations in the region where it attains mining thickness. In many parts of the county it is either too thin or too badly parted to warrant attention or development

150 miles, and amounts to about one-sixth of one degree, or about 16′ to a mile. In other words, the lowest coal bed at the base of the *Conglomerate* lies in Warren Co. just 2,000′ — and at Pittsburgh only 60′ — above tide. We have good data for placing it under Washington at tide-level, and in Greene Co., Jackson twp., about 600′ below tide-level. It falls, therefore, 2600′ in 160 miles. All the other coal beds and intermediate sandstones, shales, limestones, clay-ironstones, etc., follow the same rule and have the same slope. In obedience to this *south-west slope* their outcrop belts stretch crosswise north-west and south-east in a series of concentric curves, each one further south than that of the one below."

Following the order heretofore preserved, the *Upper Productive* or *Monongahela River Series No. XV* will first be described as it exhibits itself in the detached fields in the *Salisbury basin* in Somerset Co; the *Ligonier valley* of Westmoreland and the *West Lebanon field* of Indiana and Armstrong before taking up the main *Pittsburgh Region* in the south-west portion of the State.

*No. XV in the Salisbury Basin of Somerset County.**

The *Upper Productive Coal Measures* have been retained in the hills between Salisbury and Meyersdale to the extent of about 160′, with the massive layers of the *Great Limestone* on top making a fertile soil and furnishing an abundance of lime for exportation. The preservation of this isolated area of the *Pittsburgh coal* is due entirely to the structure of the *Berlin-Salisbury basin.*† It is slightly

*The Salisbury basin, immediately west of the Allegheny Mt. crest, is one of the most important and interesting fields in the county. Various vertical sections of the measures exposed here are shown in plate 481 as well as a contour line map of the surface and underground structure of the *Pittsburgh coal bed.* Two plates of cross sections and a series of coal bed sections of the Pittsburgh seam and the several beds of the Lower Productive coal group are given in plates 482, 483 and 484.

†Thus where Negro Mt. anticlinal first diverges from Allegheny Mt. crest in Paint twp., the entire basin is occupied by *Conglomerate No. XII.* In Shade twp. further south the lowermost coals of *Lower Productive group* sweep over nearly the whole basin and the Conglomerate is uncovered only in beds of deepest streams and on summit of Allegheny Mt.

At Berlin the *Mahoning sandstone*, 300′ thick, is at least 300′ below sur-

tilted along its center line, which has the effect of gradually deepening the trough going southwestward from Cambria Co. The structure of the basin is well shown on plates 483 and 484.

From Meyersdale to the Maryland line this famous coal bed ranges along the center of the basin, and confining itself to a narrow area until at a point about 5 miles south-west of Meyersdale, the pitch ceases and the basin begins to rise slowly to the south-west, with the inevitable effect of again carrying the coal into the air and leaving it almost without cover at the Mason and Dixon line. The coal has a striking resemblance to that of the great bed in the *Cumberland basin* in Maryland, and has shared with it a very high reputation for steam raising qualities. It is opened and worked at numerous points between the Casselman river and the Maryland line, and sections at these mines are given in plate 422.

Reference to them will show however that the bed varies very much, both in size and quality, in the limited area covered by it, deteriorating especially towards the northern end of the field, where in the *Saylor mine* its 9′ section shows only 4′ 2″ of coal, with a parting clay 2½′ about 1′ from the bottom, as against 8′ or 9′ in the lower end of the field. At the *Cumberland and Elk Lick mine*, 2 miles south-west of Meyersdale, the bed measures 8′ 6″; but it carries no less than five distinct partings, although the coal mined and shipped is of excellent

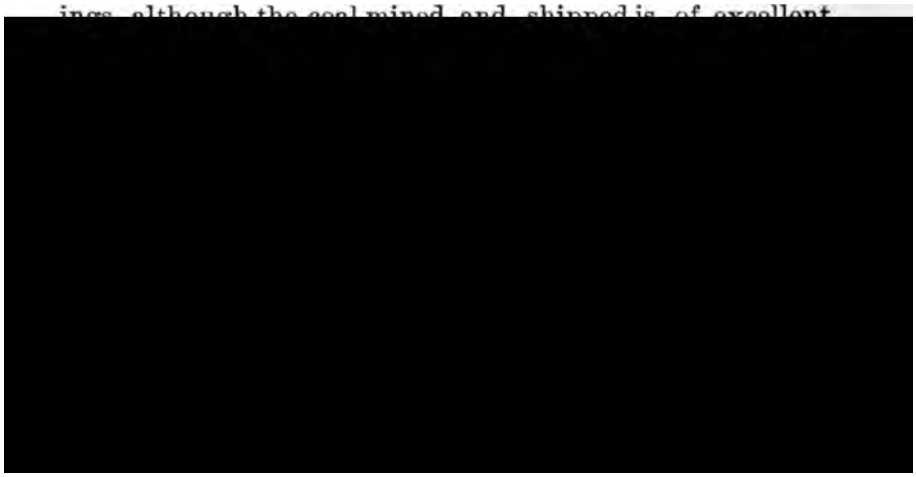
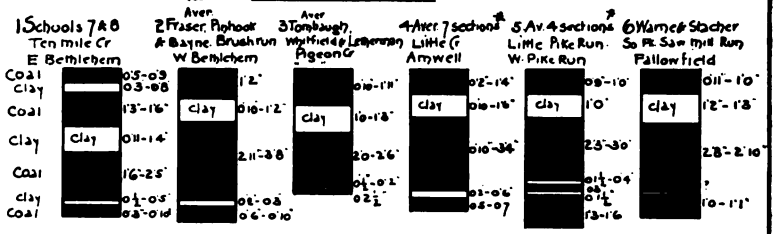


PLATE 480

No XV Monongahela River or Upper Productive Coal Series

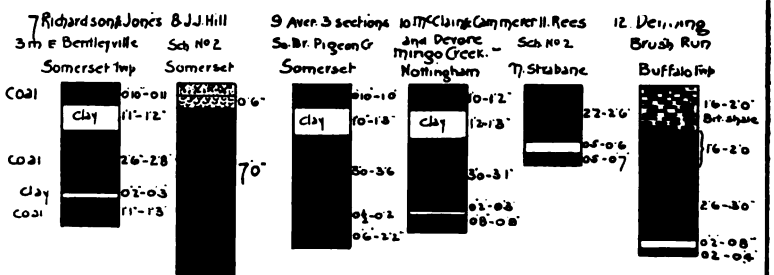
Vertical Sections. Waynesburg Coal. Washington and Fayette Counties

(a) WASHINGTON Co



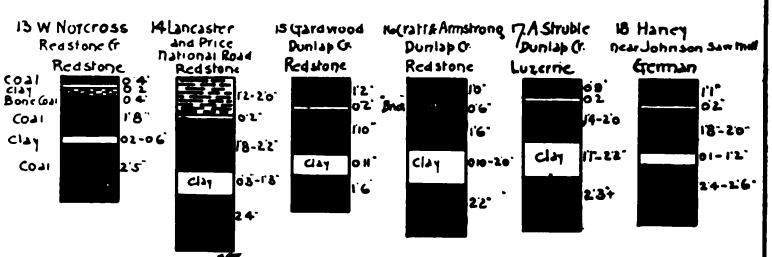
* These two groups of sections well display the excessive variation of the Waynesburg Coal
No 4 openings at Cooper; McCrury; Chamberlain; Hughes, Wise, Moninger and Ferrell.
No 5 " " Hill; Rogers; Sellers and Miller.

WASHINGTON Co
(continued)



* The three Somerset Twp Sections, Nos 7, 8 & 9 show the prevailing type of the coal bed
No 9 is an average of openings at J. Huffman Sch No 8; J.J. Huffman Sawmill; Burgen, Sch No 4.

(b) FAYETTE COUNTY.*



* East of Monongahela River the Waynesburg Coal is mainly seen S. of Redstone Creek:
in N. Fayette & Westmoreland Counties it is poor & slaty, but sometimes 4' thick.
The sections contrast strongly with Washington and Greene, especially in holding the
thick clay parting near the middle of the bed instead of near the top

B.V.D.I.

66.807%, V. M. 21%, sulphur .713% and ash 10.190%. At the *Miller mine*, in the extreme southern end of the basin, it still shows a handsome bench 8′ thick, with a slate floor, below which there is reported to occur a second bench 18″ thick. These sections might be duplicated many times.

In the southern half of the *Salisbury coal basin* a variable coal bed running up to 5′ in thickness, comes in over the Pittsburgh seam. At the Wilhelm mine on Tub Mill run it is 6′ above the top of the Pittsburgh bed and shows 6′ 1″ thick; but only the lower bench 3′ 8″ is of good quality, the balance being banded with slate. This "*rider coal*" shows everywhere through the southern centre of the basin, ranging from 6′ to 12′ above the main bed; but to the north of the Graham mine, in all the numerous places in which the roof slates of the Pittsburgh coal bed were exposed, the rider coal was missing, though in some places 20′ of roof slates are exposed.

The *Redstone coal bed* lies from 40′ to 50′ above the Pittsburgh seam, averaging close to 44′ throughout the basin; but it was nowhere worked except where it is quarried with its limestone at the Beachy quarry. Its coal is very similar in character to that yielded by the Pittsburgh bed but it is much more sulphurous. It was once opened at the *Keystone mines* 2½ miles south-west of Meyersdale, showing a top bench 1′ 6″, carrying bone and slate, and a bottom bench 4′. It has no commercial value whatever.

The *Pittsburgh limestone group* in this basin consists of three members; *First*, the "upper limestone," 160′ above the Pittsburgh coal. *Second*, the "middle limestone," 90′ above the Pittsburgh coal. *Third*, the "Redstone limestone" 30′ above the Pittsburgh bed (see plate 481.)

The *upper* and *middle limestones* are regular and persistent, and are traced throughout the basin with a small coal bed upon top of each of them. The *Redstone limestone* shows plainly at the south-west end of the basin on the old Miller place; but it is not found on adjoining properties, and is only reported to show in one other part of

the basin, 1 mile south of Mechanicsburg, so that it probably does not exist in the northern part of the basin at all. At Millersville it is 10′ thick, separated from the overlying Redstone coal by 6′ of impure fire clay, shale and black slate.*

The Middle (*Sewickley*) limestone and coal is but little opened in this basin, though occurring with great regularity 90′ above the Pittsburgh coal. Above Saylor's mine it is 5′ thick, in two layers, the upper one of which is fossiliferous and lighter in color than the lower. It has been extensively quarried and burned at the Keim and Livengood mine, half mile north of Salisbury, where it shows in all 15′ thick, with three layers of limestone, 1′, 2′ and 4′ thick. It averages 6′ to 8′; its coal is worthless.

The Upper (*Uniontown*) limestone and coal is opened and worked at numerous places, everywhere regular and persistent. West of Meyersdale it shows on the hill top, filled with fossil shells.

One-half mile to the south-west it shows two benches, separated by 10″ of clay, the lower, massive, 10′ thick, the upper 1′ 6″ thick, separated by an equal interval from the coal bed 2′ thick. It averages fully 10′ of good limestone in the whole basin.

In a resumé of the total acreage of the *Pittsburgh coal bed* in the *Salisbury basin*, made by Mr. F. Platt in 1876 on the basis of the topographical map of the region,† it was shown that there existed 3,615 acres, which with due

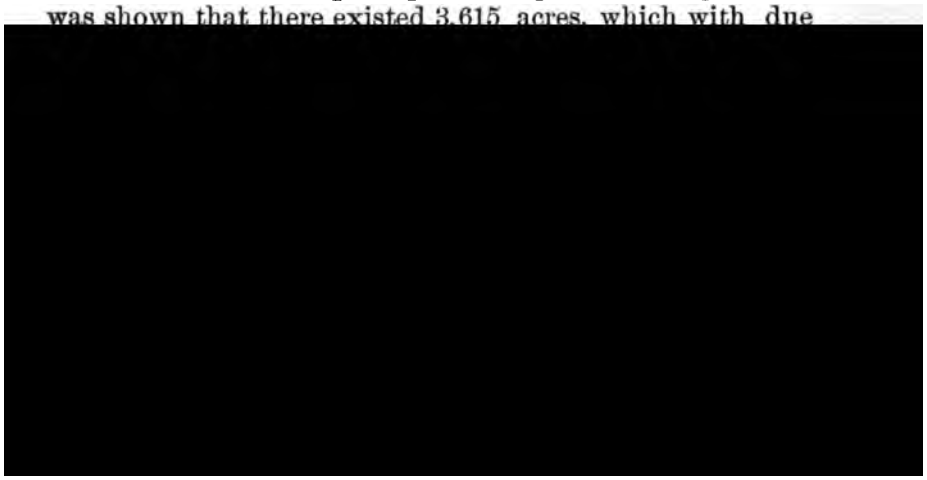


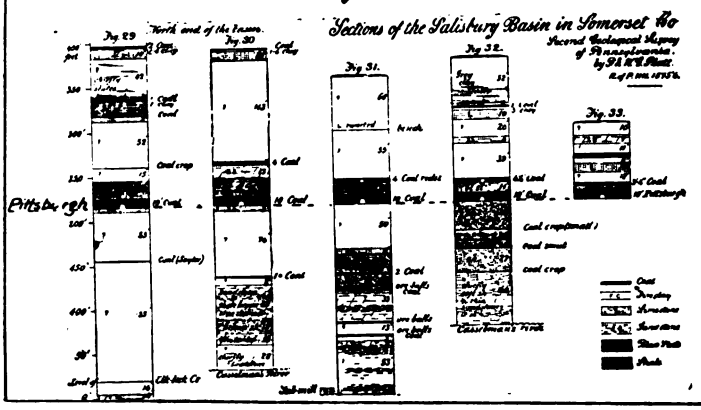
PLATE 481.

Jr°XV Monongahela River Coal Series Somerset Co

Salisbury Basin



Vertical Sections of the Upper Productive Group



more closely the coal yielded by one of the bed of the Lower Productive Coal Measures in the Clearfield region. For convenience of comparison some analyses of coals from these regions are tabulated below: (See HHH p. 101.)

Pittsburgh Bed in the Salisbury Basin.

Water,	1.385	1.050	1.665	1.680
Volatile matter,	21.470	19,610	22.350	21.010
Fixed carbon,	69.352	70.239	68.774	69.016
Sulphur,	.763	.761	1.246	.764
Ash,	7.030	8.340	5.965	7.530
	100.000	100.000	100.000	100.000
Coke,	77.145	79.340	75.915	77.310

Pittsburgh Bed in the Cumberland Basin.

Moisture,	0.669	0.446	0.893	3.125
Volatile matter,	14.984	15.532	15.522	14.168
Fixed carbon,	76.264	76.688	74.289	68.438
Sulphur,				0.714
Ash,	8.083	7.334	8.296	14.933
	100.000	100.000	100.000	100.000
Coke,	84.347	84.022	83.585	85.829

Clearfield Coals.

Water,	0.810	0.780	0.710	0.765
Volatile matter,	20.640	21.680	23.400	20.090
Fixed carbon,	74.023	73.052	72.218	74.779
Sulphur,	.507	.688	.532	.666
Ash,	4.020	3.800	3.140	3.700
	100.000	100.000	100.000	100.000
Coke,	78.550	77.540	75.890	79.145

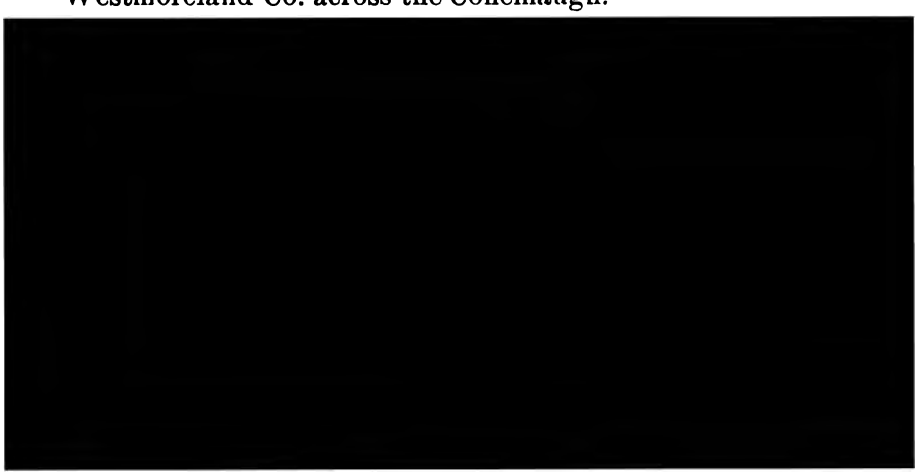
No. XV in Indiana County.

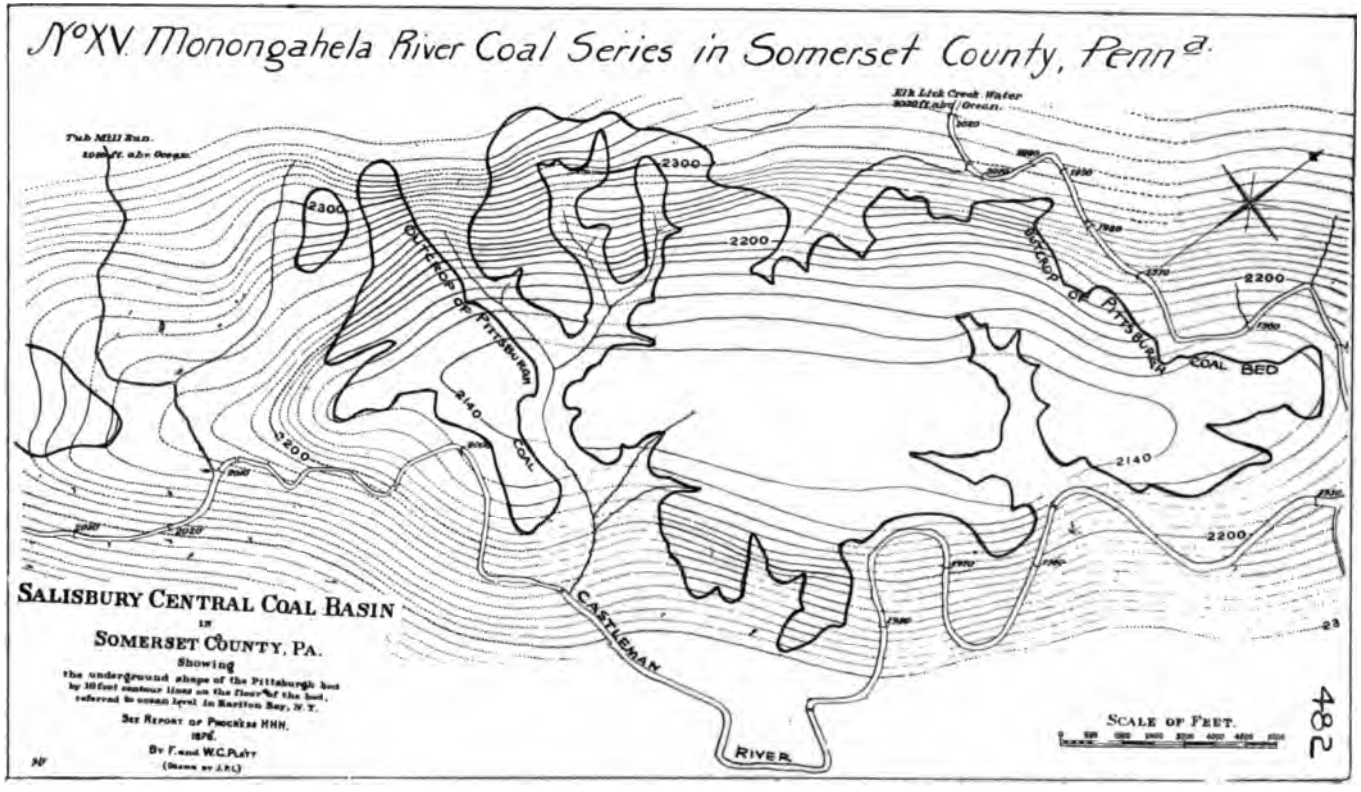
Insignificant areas of the *Upper Productive Measures* occur in this county, in both the *Blairsville* and the *West Lebanon-Saltsburg basins.* In the former they are confined to some few patches on either side of Black Lick creek. The Pittsburgh coal outcrop is 5 miles west of the center of the Chestnut Hill axis, and only 1½ miles east of the Indiana axis. which at once suggests the uneveness of

dip in the trough. Its floor is tilted to the south-west too, hence limiting the north-east spread of the bed.

The Pittsburgh sandstone is well exposed in the cliffs at Blairsville, and often completely fills the interval up to the *Redstone coal*, frequently almost directly capping the *Pittsburgh coal.** It carries a conspicuous oblique bedding, and is persistently 40′ thick, not only in this county, but all through the basin to Uniontown. The *Sewickley limestone* has a considerable range, and its upper layers have been quarried, yielding excellent stone, fossiliferous, semi-crystalline and brown in color.

The *Sewickley coal bed* is the highest exposed stratum, which in one place has 40′ of measures over it; but the most important member is of course the *Pittsburgh coal*, at the base of the group. It has a maximum thickness of about 6½′ covering about 1 square mile. Its character can be judged from three vertical sections of the bed given on plate 468, together with three additional figures from the *West Lebanon basin*, along the Armstrong line, drawn from comparison. The coal possesses little commercial value except to the immediate neighborhood; but as a local supply, for domestic coal and calcining the limestones of the district, the deposit will always demand attention, owing largely to the size of the bed and its accessibility. Its coal is everywhere of inferior chemical quality, as it is in northern Westmoreland Co. across the Conemaugh.




N°XV. Monongahela River Coal Series in Somerset County, Penn.a.
Tub Mill Run.
Elk Lick Creek Water
2300
2200
2140
OUTCROP OF PITTSBURGH COAL
OUTCROP OF PITTSBURGH COAL BED
CASTLEMAN RIVER
SALISBURY CENTRAL COAL BASIN
IN
SOMERSET COUNTY, PA.
Showing
the underground shape of the Pittsburgh bed by 10 feet contour lines on the floor of the bed, referred to ocean level in Raritan Bay, N.Y.
See Report of Progress HHH.
1878.
By F. and W.C.Platt
SCALE OF FEET.
482



floor smooth and regular and "*horse backs*" and "*clay veins*" are very rare. East of the town of Blairsville it is first seen at Mr. Mahers' house and south towards the river it is opened by T. Sloane (see figure 1, plate 468), nearly opposite the Coketon ovens. It carries 1′ of dark clay and bone coal on top; coal, main bench 3′ 8″ to 3′ 10″; slate 0′ 1½″, and coal, bottom bench 1′ 10″ to 2′ 0″, in all about 6′ thick. The coal contains F. C. 49.748%; V. M. 27.385%; sulphur 3.017%; ash 19% and water .850%. The high percentage of both ash and sulphur would render the coal worthless in the open market, and both are undoubtedly due to thin bands of bony pyritous coal streaking the main benches.

At the *Smith and Turner mines* near Smith's station on the Indiana R. R., the coal has been extensively mined. In the former opening it shows the same character and section as at Sloane's, being a trifle thicker by reason of the coal benches varying between 3′ 8″ to 4′ 0″ for the upper and 1′ 6″ up to 2′ 4″ for the lower giving a section of 6′ 5″. As elsewhere all the roof division of the Pittsburgh region is wanting; but the overclay is here 1′ 0″ thick, above which there is a thin streak of coal—all there is to represent the upper division. The main bench alone gives sulphur 2.571% and ash 10.955%. West of the Smith hill is the McCrea area of coal, extending to T. Repine's and south-west to include two small patches on the S. McCrea and J. Wiley farms, on all of which properties it maintains its full average thickness.

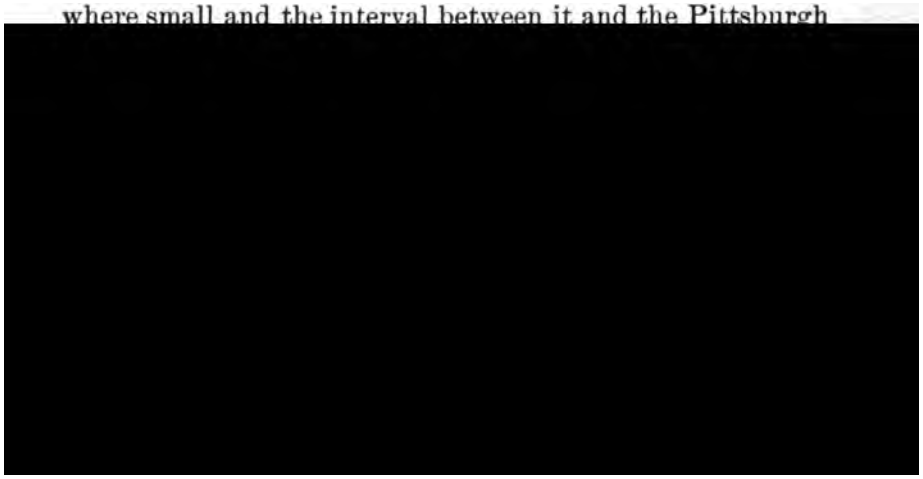
On the Coleman property, overlooking Black Lick by by 245′, it is again mined and after crossing that creek, it catches first in the Campbell farm, and finally in the Doty and J. Dixon farms, embracing the most important area of this coal north of the Black Lick. In the Doty mine (see plate 468) the coal is regular and uniform and is comparatively free from iron pyrites; but it here carries two thin slates, enclosing coal 0′ 3″ beneath the main bench 3′ 5′, and shows 1′ 4″ of bony coal in the bottom of the lower bench 3′ 2″. Hence the bed only yields about 4′ 6″ of clean

coal of which a sample of the main bench shows sulphur .849% and ash 10.190%.

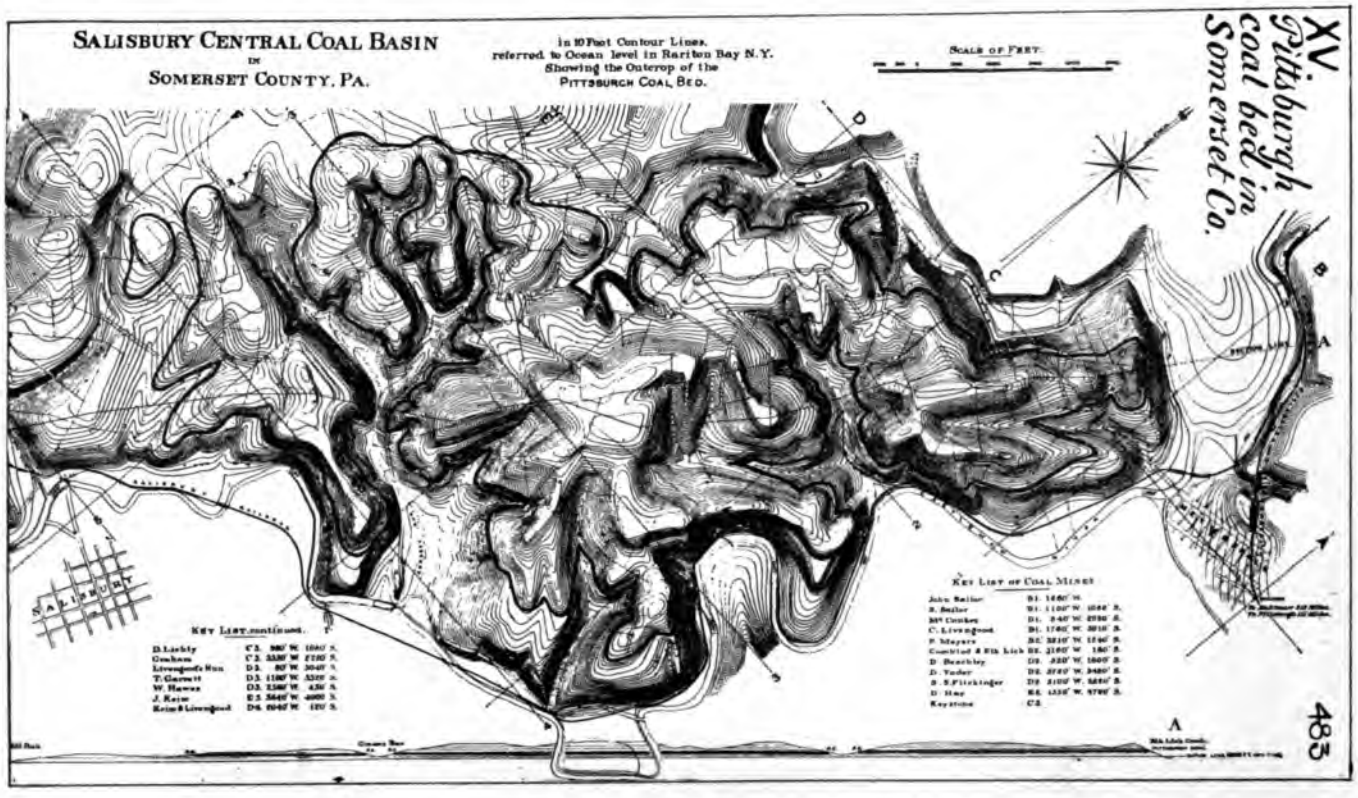
In the *West Lebanon basin*, at Saltsburg as at Blairsville, the Pittsburgh coal crosses the Conemaugh from Westmoreland Co.; but here to make a much longer and wider outcrop than in the Blairsville basin, extending for 10 miles along the Armstrong Co. line to beyond West Lebanon. This is therefor a much more important area, its limits geographically defined by Gobbler's run on the north; Black Legs creek on the east; the Conemaugh on the south and by Long's run in Armstrong on the west—an area 9 miles by 2½ miles. Nowhere in this basin are there more than 200′ of the Upper Productive Measures exposed; rarely more than 100′.

Elder's ridge, 4 miles north-east of Coalport, is the highest geological ground in the basin, and shows outcrops of the *Great Limestone; Sewickley coal and limestone; Redstone coal; Pittsburgh sandstone* and at the base the *Pittsburgh coal bed.* The Great Limestone is nowhere else found, and is here, with its several shale bands, fully 25′ thick, furnishing a compact, non-fossiliferous stone, making a strong agricultural lime (see Armstrong section, plate 469.)

The *Sewickley coal* is found at several places, 3′ to 5′ thick, but generally worthless. The Sewickley limestone on the Conemaugh is 6′ thick; the Redstone coal is everywhere small and the interval between it and the Pittsburgh



XV. Pittsburgh coal bed in Somerset Co.





parted seam in the *Saltsburg-West Lebanon basin*, though maintaining a thickness of from 8′ to 11′ very generally from the Conemaugh to West Lebanon. It also carries from 5 to 7% more volatile hydrocarbons than at Blairsville and so far as analysed, rather less sulphur. Generally speaking, only the lower portion of the seam is mined, owing to the numerous slate partings in the roof coal.

Along the Conemaugh in the past the bed has been largely mined from the *Rhea property* near Coalport and by the *Loyalhanna C. & C. Co.* In the vicinity of Clarksburg there are also numerous openings.

No. XV in Armstrong County.

The *Upper Productive System*, or Monongahela River Series, occupies a few isolated areas north of the Kiskiminitas river along the Indiana Co. line,* with a fragment of the Great Limestone preserved on the summit of Elder's Ridge. This (*Lisbon*) coal basin is 6 miles long and about 1 mile wide, pitching south-west; but as the Armstrong area is merely the western half of the West Lebanon basin, all its coal dips south-east towards Indiana Co.

The *Sewickley coal* lies about 80′ beneath the Great Limestone with a general average of 3′, varying between 1′ and 5′; not mined. The *Redstone coal*, 56′ lower, varying everywhere between 1′ and 3′, and frequently absent entirely, is never workable or merchantable. The Pittsburgh sandstone beneath it is extremely variable, sometimes massive, sometimes current bedded, flaggy and shaly, but always averaging 35′ in thickness, preserving the coal.

The *Pittsburgh coal*, though always 8′ to 10′ thick, is generally so split up by bands of slate as to be of little commercial value outside of use for domestic supply. The old works at Coalport made extensive shipments prior to a

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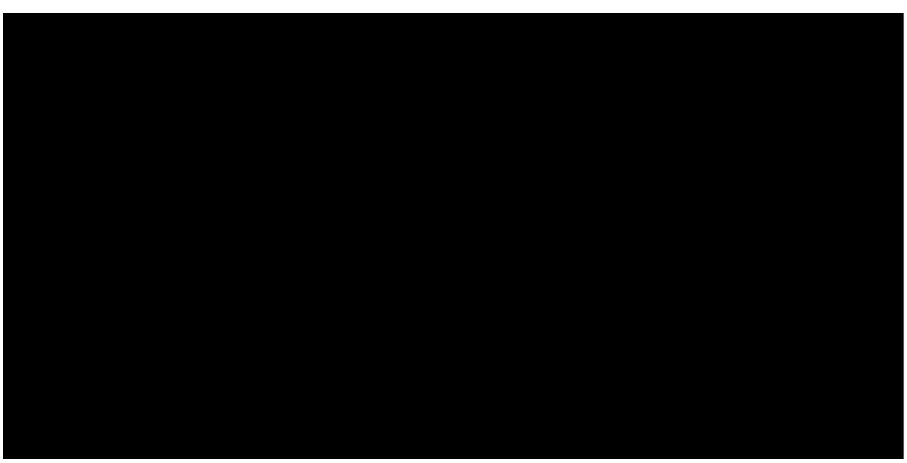
1.465% and ash 9.705%. In extreme north end of basin the bed is at its best, free from impurities and bears an excellent reputation. In the George mine the *Roof Div.* is 1′ 6″; parting 1′ 0″ and *Lower Div.* 6′ 6″, with all partings (3) thin; coal good.

*It is an integral part of the *West Lebanon field* of that county, separated geographically by the county line.

demand for better fuel; but the coal is both pyritous and slaty. So too the Rhea and Smith mines. Beyond Maysville, on the Carathers and Ferrman farms, its lower portion 6′ 3½″ is mined, with a foot of top coal and carrying two slate bands of 3″ and 0½″ thick.

In the Elder's Ridge region the seam has been more extensively mined on the Ewing farm for local use. Here the bed is at its thickest and shows its three divisions: Roof, coal and slate, 2′ 10″; Main clay parting 0′ 10″; and Lower Division 8′ to 8′ 8″. The coal in all the different divisions is slaty and poor, and some of it highly pyritous. Still it mines out in compact cubical blocks, bearing transporation much better than the soft *Freeport coals* and hence largely preferred despite its carrying over 3% sulphur and 9% ash. The lower division carries four distinct slate partings. How seriously they affect the commercial integrity of the seam may be judged by inspecting Figure 3 plate 469, where also a general vertical section of the Upper Productive group is shown, extending up to the Great Limestone, poorly exposed and 207′ thick.

The *Sewickley limestone* is generally obscure, but is compact and well seen in the Coalport cliffs and near Olivet. It is indeed remarkable however to see thick beds preserving their character and position over such wide areas, equally with the unique Pittsburgh coal seam which they cover.



Nº XV. Monongahela River Coal Series in Somerset Co. Comparative Cross-Sections.

First Bituminous Coal Basin in Somerset Co. Pennsylvania.

(First Sub-Basin)

Fig. 9.

BERLIN.

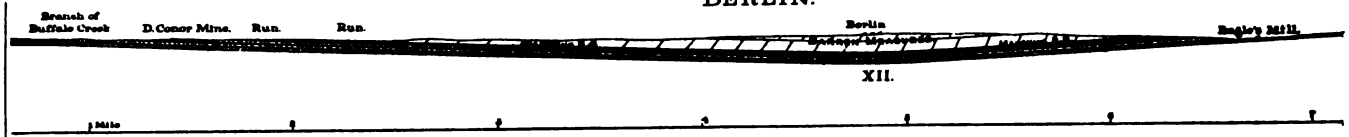
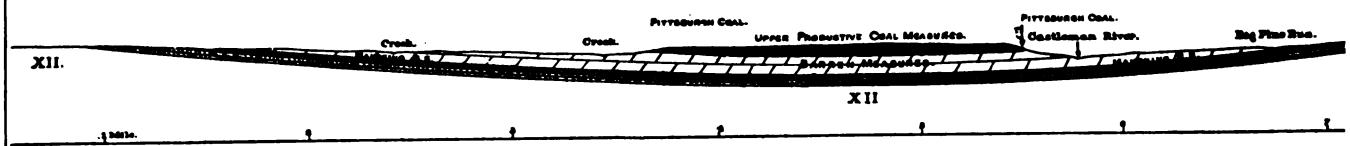


Fig. 26.

SALISBURY.





limestone bands near the very top, no measurement of these could be made.

The *Sewickley coal*, here about 85′ above the base, is doubtfully represented by 6″ of dark carbonaceous slate; the *Fishpot limestone* beneath shows at Brenizer's quarry 8′ thick, but nowhere else to the north. The *Redstone coal* is also obscure, and its limestone is a variable rock 4′ to 10′ thick, becoming argillaceous in the northern end of the area. Some layers yield an excellent lime and some a cement rock. Beneath it occur 5′ of black shale and then a persistent coal streak, extending south to beyond the line of Fairfield twp., but not opened. The interval between the Redstone limestone and Pittsburgh coal decreases towards the north; near Meyers school house in Ligonier twp. it is 45′ while 3 miles north in Fairfield it is barely 25′.

The *Pittsburgh coal* is usually single, its roof division being concealed or contained as coal streaks in the overlying black shale. Five sections of the bed are given on plate 470 all noting the absent of this member. The divisions of the *Lower Division* are quite different from the Monongahela River character, the bed varying from 7′ to 8′, with sometimes two and sometimes three partings. The coal is generally soft, with a prismatic structure, and through the entire field should yield about 2000 acres of commercial coal.

Personal sections were made recently in three different banks, with the following results; Nos. 1 and 2 in the north end of the basin and No. 3 in the south end. All show columnar coal, friable and soft; the bands contain slate and sulphur, which also sometimes streak the main bench. The coal dips to a basin having a south-west pitch.

1. *Hartman No. 2 Mine.*			2. *Robb.*		3. *Tallmans.*	
Bony coal,		0′ 2″				
Coal,		4′ 0″		3′ 2″		3′ 7!′
Slate,	0′ 0½′		0′ 0½′		0′ 0½″	
Coal,	0′2″	0′ 3	0′ 5″	0′ 6″	0′ 3′	0′ 3½″
Slate,	0′ 0½″		0′ 0½′		0′ 0½″	
Coal,		1′ 0″				
Coal, bottom,		0′ 9′		2′ 10″		1′ 7½′

Samples of the merchantable coal in the first and third

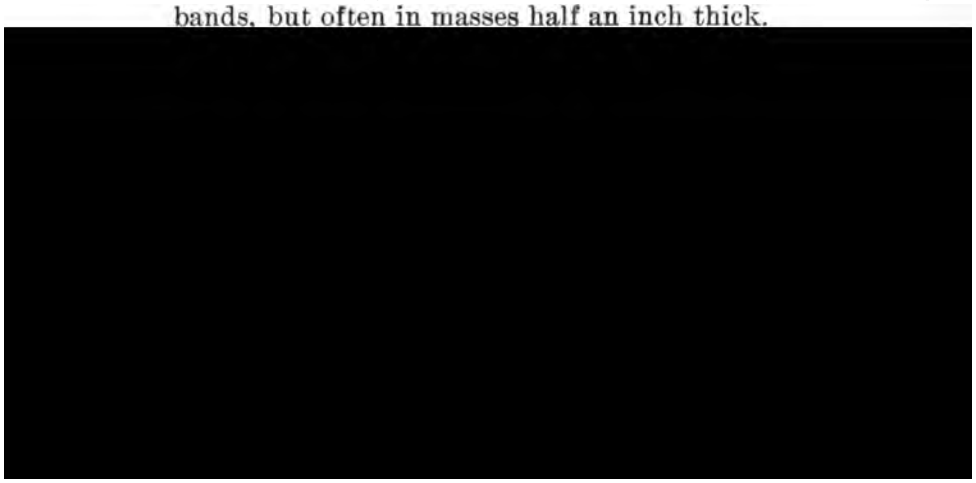
mines, respectively 5′ and 5′ 2″, exclusive of binders, yielded as follows :

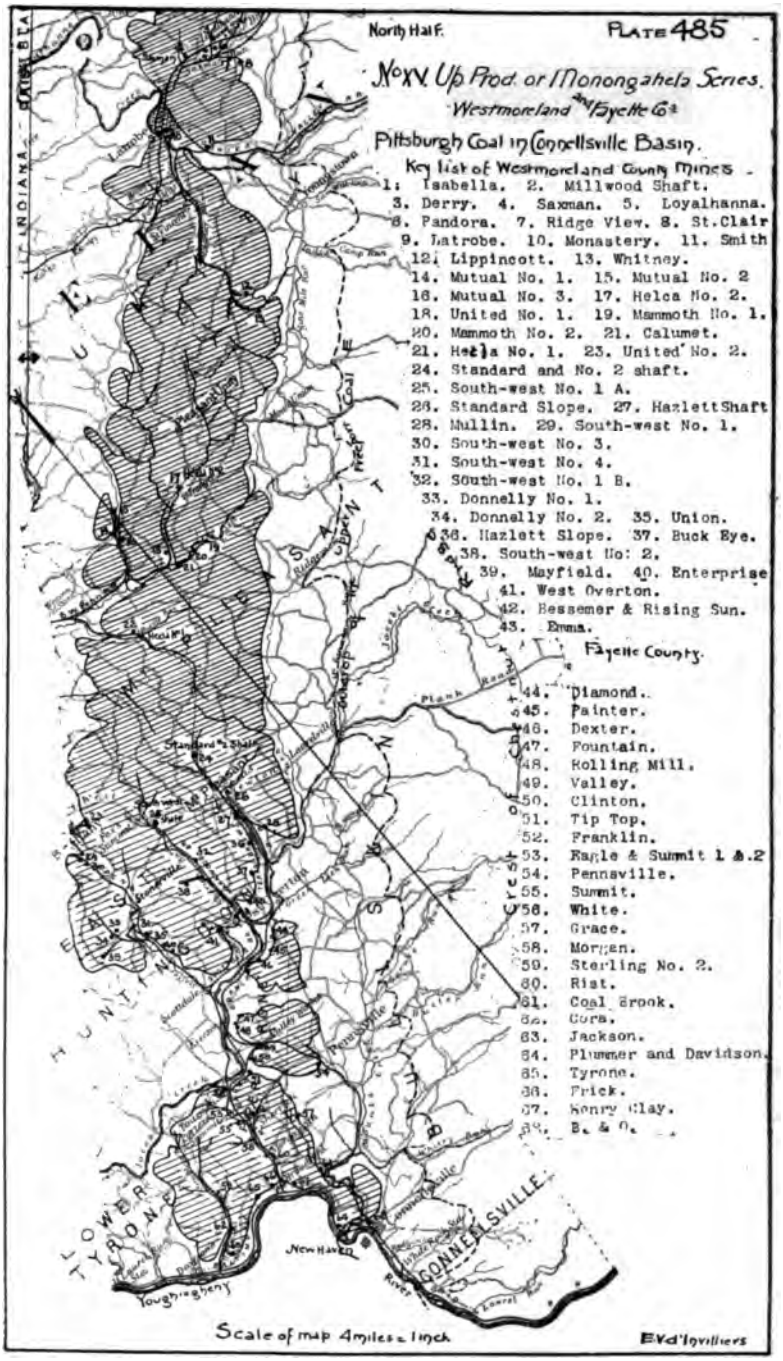
	No. 1	*No. 8*
Water,	1.336	1.534
Volatile matter,	24.227	23.156
Fixed carbon,	63.842	64.742
Sulphur,	.725	.880
Ash,	9.870	9.680

These show the coal at its best; other analyses report as much as 3% sulphur and ash ranging from 6% to 9%.

In *Ligonier twp.* it has been mined by *T. Seaton* 8′ 5″, the brick coal and partings occurring 3′ above floor and 2″ thick. Horse backs and squeezes vary this section, but clay veins are conspicuously absent. At the *Knox bank* it shows 8′ thick; but the top 7″ is slaty coal, and then benches of 2′, 2′ 8″ and 2′ 8″ with thin slate partings between. The same character prevails at the *Breniser bank* toward Mill creek, where the coal benches are 1′ 9″, 2′ 7″ and 2′ 8″.

In *Fairfield twp.* the coal is opened at a number of places. At *Cauffields* the coal benches are 2′ 8″, 1′ 10″ and 3′, with a clay parting between the last two; at *Smiths* 1′ 10″, 1′ 11″ and 2′ 2″, with this clay expanded to 1′, with streaks of coal, and a bottom layer of 8″ of slaty coal. (See plate 470). At all places the Pittsburgh coal in this area seems to be very free from horsebacks and clay veins and the pyrite occurs mainly in the separating clay bands, but often in masses half an inch thick.




North Half.
PLATE 485
No XV. Up Prod. or Monongahela Series.
Westmoreland and Fayette Cos
Pittsburgh Coal in Connellsville Basin.
Key list of Westmoreland County Mines
1. Isabella. 2. Millwood Shaft.
3. Derry. 4. Saxman. 5. Loyalhanna.
6. Pandora. 7. Ridge View. 8. St. Clair
9. Latrobe. 10. Monastery. 11. Smith
12. Lippincott. 13. Whitney.
14. Mutual No. 1. 15. Mutual No. 2
16. Mutual No. 3. 17. Helca No. 2.
18. United No. 1. 19. Mammoth No. 1.
20. Mammoth No. 2. 21. Calumet.
21. Helca No. 1. 23. United No. 2.
24. Standard and No. 2 shaft.
25. South-west No. 1 A.
26. Standard Slope. 27. Hazlett Shaft
28. Mullin. 29. South-west No. 1.
30. South-west No. 3.
31. South-west No. 4.
32. South-west No. 1 B.
33. Donnelly No. 1.
34. Donnelly No. 2. 35. Union.
36. Hazlett Slope. 37. Buck Eye.
38. South-west No: 2.
39. Mayfield. 40. Enterprise
41. West Overton.
42. Bessemer & Rising Sun.
43. Emma.
Fayette County.
44. Diamond.
45. Painter.
46. Dexter.
47. Fountain.
48. Rolling Mill.
49. Valley.
50. Clinton.
51. Tip Top.
52. Franklin.
53. Eagle & Summit 1 & 2
54. Pennsville.
55. Summit.
56. White.
57. Grace.
58. Morgan.
59. Sterling No. 2.
60. Rist.
61. Coal Brook.
62. Cora.
63. Jackson.
64. Plummer and Davidson.
65. Tyrone.
66. Frick.
67. Henry Clay.
68. B. & O.
INDIANA
WESTMORELAND
FAYETTE
Pittsburgh Coal
Upper Connellsville Coal
Lower Connellsville Coal
Latrobe
Derry
Youghiogheny
New Haven
CONNELLSVILLE
Scale of map 4 miles = 1 inch.
E Vd Ivilliers



Chestnut ridge forms a long straight eastern mountain wall, separating it from the *Ligonier basin*, whilst its western boundary is the *Indiana* or *Blairsville axis* from the Conemaugh to beyond the Penna. R. R. at Carr's tunnel, and south of Big Sewickley creek, the *Fayette axis** in Brush ridge (see plates 485 and 486.) This latter axis rises north-east 20′ per mile in 18 miles between the State Line and Redstone creek; from here the axis is nearly level as the *Freeport upper coal E* appears under its arch on the Youghiogheny, Jacob's creek and Big Sewickley at nearly the same elevation. On the other hand the structure of the basin is quite different. From the Conemaugh to the Youghiogheny, it shows little variation in width; but it gradually narrows from there towards West Virginia. It attains its greatest (geological) depth near the Youghiogheny and becomes more shallow north and south. Roughly speaking the Pittsburgh coal near the bottom of the trough, has an elevation of 1030′ A. T. on the Cheat river; 700′± at Uniontown and somewhat less on the Youghiogheny; on the S. W. Penn. R. R. 1070′; on the Penna. R. R. at Loyalhanna somewhat less than 1000′, and on the Conemaugh about 1000′ (see plate 487 for bird's eye view of basin and typical sections of coal bed.)

square miles or 87,680 acres of coal 8′ to 10 thick, of which about 60,000 acres are still unmined, or 450 million tons. It is difficult to assign any arbitrary commercial limit to this basin, for pending the progress of development its centre has been moved successively from Connellsville to Mt. Pleasant and then to Pleasant Unity. While the great seam (whose coal makes the typical coke of the United States) undoubtedby undergoes certain physical changes going northward to the Penna. R. R., it is quite certain that the coke made thereabouts has proven itself as good physically and chemically (after screening the coal but without resort to washing) as much that is made further south in Westmoreland and northern Fayette Cos.

* Near the West Virginia line the expiration of this axis permits the *Connellsville coking coal basin* and the *Lisbon gas coal basin* to coalesce, with the *Pittsburgh coal* riding over the axis south of Smithfield, so that continued south along the Monongahela into West Virginia this united basin holds a magnificent area of the Pittsburgh seam, 8′ to 10′ thick, which in structure and chemical contents partakes of both types, its slack and nut coal making an excellant coke, low in phosphorus, while its lump coal can be used for gas making and steam coal. These remarkable attributes will undoubtedly lead to a very great development of this *Upper Monongahela field* in the near future.

The *Conemaugh*, *Jacobs creek* and the *Cheat river* completely cut out the Pittsburgh coal and expose considerable sections of the underlying *Barren Measures;* but this bed is continuous under the *Redstone* and *Youghiogheny* in Fayette and under the *Loyalhanna* in Westmoreland Co.

Referring to plates 507 and 527 showing the sequence of the *Upper Productive Series*,* it may be said that at the present time only the *Pittsburgh coal* at the base receives any attention in a commercial sense.†

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*Three carefully measured sections of this rock series in the lower end of the *Connellsville field* are given on plate 488.

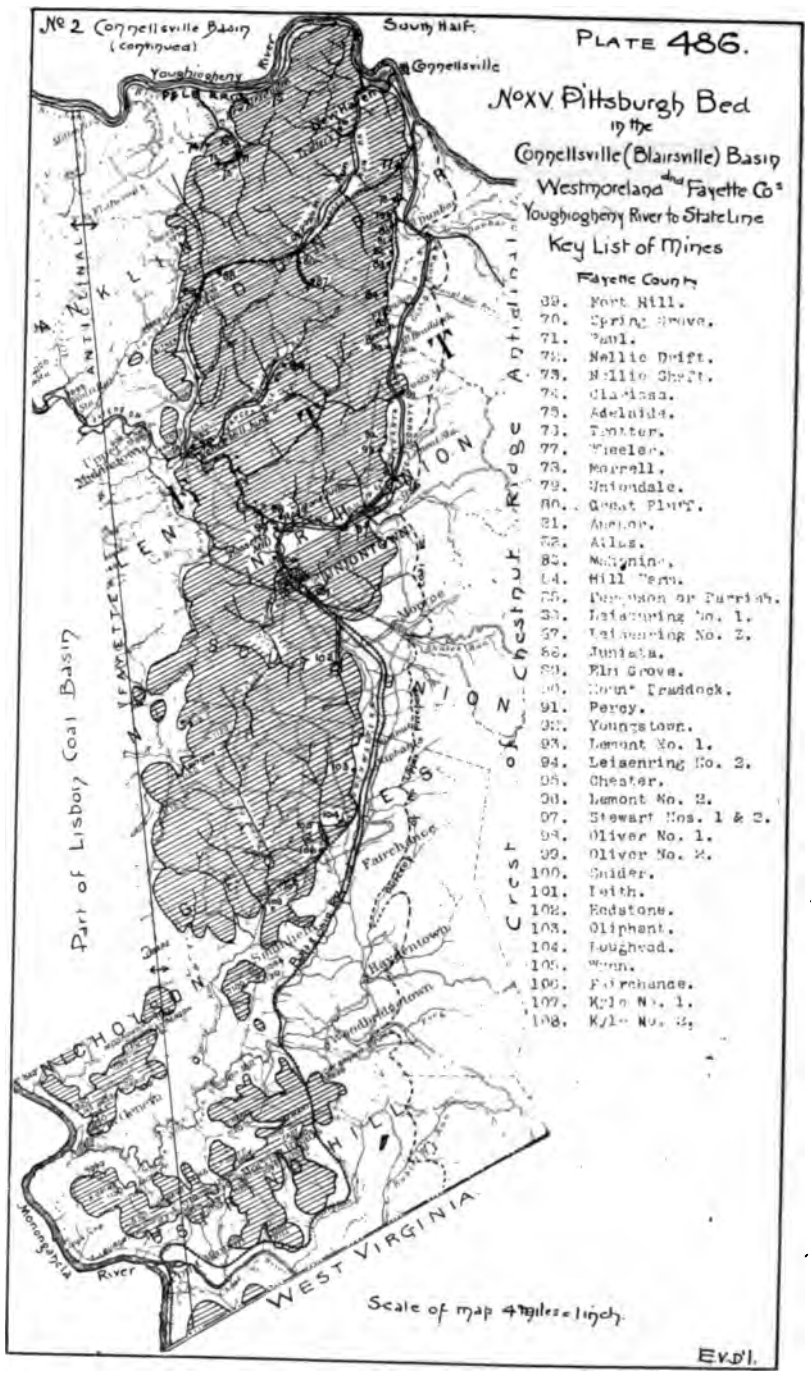
†The *Waynesburg coal* shows in central portion of basin, and its blossom north of Penna. R. R.; in south end it does not exceed 2′. In both Mt. Pleasant and Unity twps. it is 4′ to 5′ thick, but only in patches of inferior coal. The *Little Waynesburg coal* is merely black shale in this basin.

The *Waynesburg limestone* is always present from Georges twp. of Fayette to Derry in Westmoreland, beyond which point its horizon is not reached. Rarely exceeds 6′; often much thinner, and entirely displaced around Uniontown by overlying sandstone.

The *Uniontown coal* attains chief development in Fayette Co. near county seat; here a double bed, 3′ thick, generally inferior, retaining this thickness almost to Youghiogheny river. It is generally thin and obscure.

The *Great Limestone*, divided into two main divisions in Greene and Washington Cos. west of Monongahela river, still keeps upper member distinct here, whilst lower member is largely subdivided. The *Upper Division* extends north to southern Unity twp. At Uniontown compact, in two layers, total 10′, manufactured into cement; varies from 6′ to 10′ elsewhere and well exposed in Georges, N. and S. Union and Dunbar twps. Obscure north of Youghiogheny until reaching Mt. Pleasant twp., whence to Pleasant Unity it is frequently exposed. The *Lower Division* extends from State Line to Derry twp. north of Penna. R. R. except in Springhill, where most




No 2 Connellsville Basin (continued)
South Half
PLATE 486.
Youghiogheny
Connellsville
No XV Pittsburgh Bed
in the
Connellsville (Blairsville) Basin
Westmoreland and Fayette Co's
Youghiogheny River to State Line
Key List of Mines
Fayette County
89. Mont Hill.
70. Spring Grove.
71. Paul.
72. Nellie Drift.
73. Nellie Shaft.
74. Claudina.
75. Adelaide.
76. Trotter.
77. Wheeler.
78. Morrell.
79. Uniondale.
80. Great Plurt.
81. Auston.
82. Ailes.
83. McClaine.
84. Hill Farm.
85. Percyton or Parrish.
86. Leisenring No. 1.
87. Leisenring No. 2.
88. Juniata.
89. Elm Grove.
90. Mont Braddock.
91. Percy.
92. Youngstown.
93. Lemont No. 1.
94. Leisenring No. 3.
95. Chester.
96. Lemont No. 2.
97. Stewart Nos. 1 & 2.
98. Oliver No. 1.
99. Oliver No. 2.
100. Snider.
101. Leith.
102. Redstone.
103. Oliphant.
104. Lougheed.
105. Penn.
106. Fairchance.
107. Kyle No. 1.
108. Kyle No. 2.
Part of Lisbon Coal Basin
Crest of Chestnut Ridge Anticlinal
ANTICLINAL
SYNCLINAL
Scale of map 4 miles = 1 inch.
Ev.D'l.

by Mr. A. S. McCreath, from mines at *Broadford* on the Youghiogheny yields:

	Coal.	*Coke.*
Water,	1.260	0.300
Volatile matter,	30.107	0.460
Fixed carbon,	59.616	89.576
Sulphur,	.784	0.821
Ash,	8.233	9.113
Phosphorus,*		0.014

The average of quite a number of determinations in 1893 as reported by the *H. C. Frick Coke Co.*, shows coal and coke of the following composition:—

	Coal.	*Coke.*
Water,	1.130	.070
Volatile matter,	29.812	.880
Fixed carbon,	60.420	89.509
Sulphur,	.689	.711
Ash,	7.949	8.830

The coke from this region is of silvery lustre, cellular, with a metallic ring, tenaceous, comparatively free from impurities, capable of bearing a heavy burden in the furnace, and is manufactured solely in the *Bee Hive oven.*†

---

*A. S. McCreath, Vol. VIII A. I. M. E. "*Phos. in Bit. Coal & Coke.*"

In an interesting table of analyses showing *phosphorus* in various coals and cokes of the State which enter into metallurgical use, he cites 24 samples of the *Pittsburgh coal* in Greene, Washington, Westmoreland and Fayette Cos., showing extremes in coal of a trace to .1248% and in coke from a trace to .2003%. Six samples came from the *Blairsville basin*, as follows:

	Phos. in coal.	*Phos. in coke.*
1. Millwood Coal Co., Derry twp.,	.0801	.1177
2. Saxman & Co. " "	.0167	.0247
3. Frick & Co. Connellsville twp.,	.0111	.0161

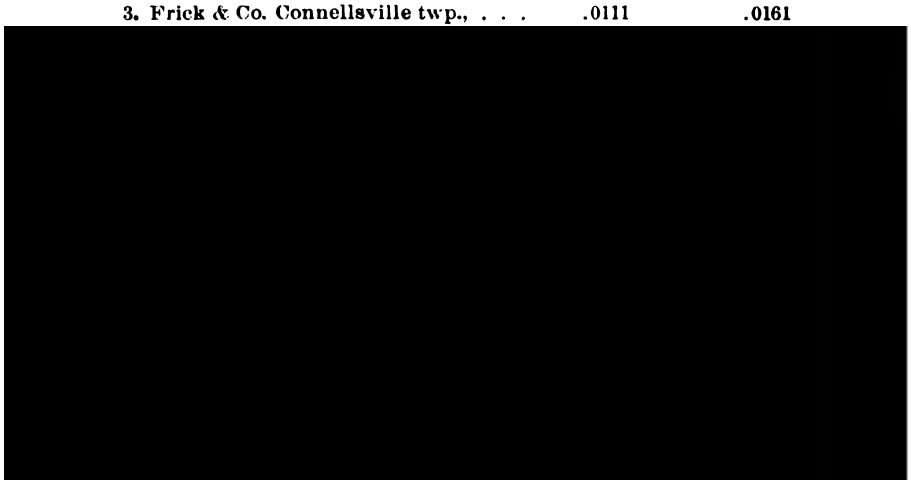
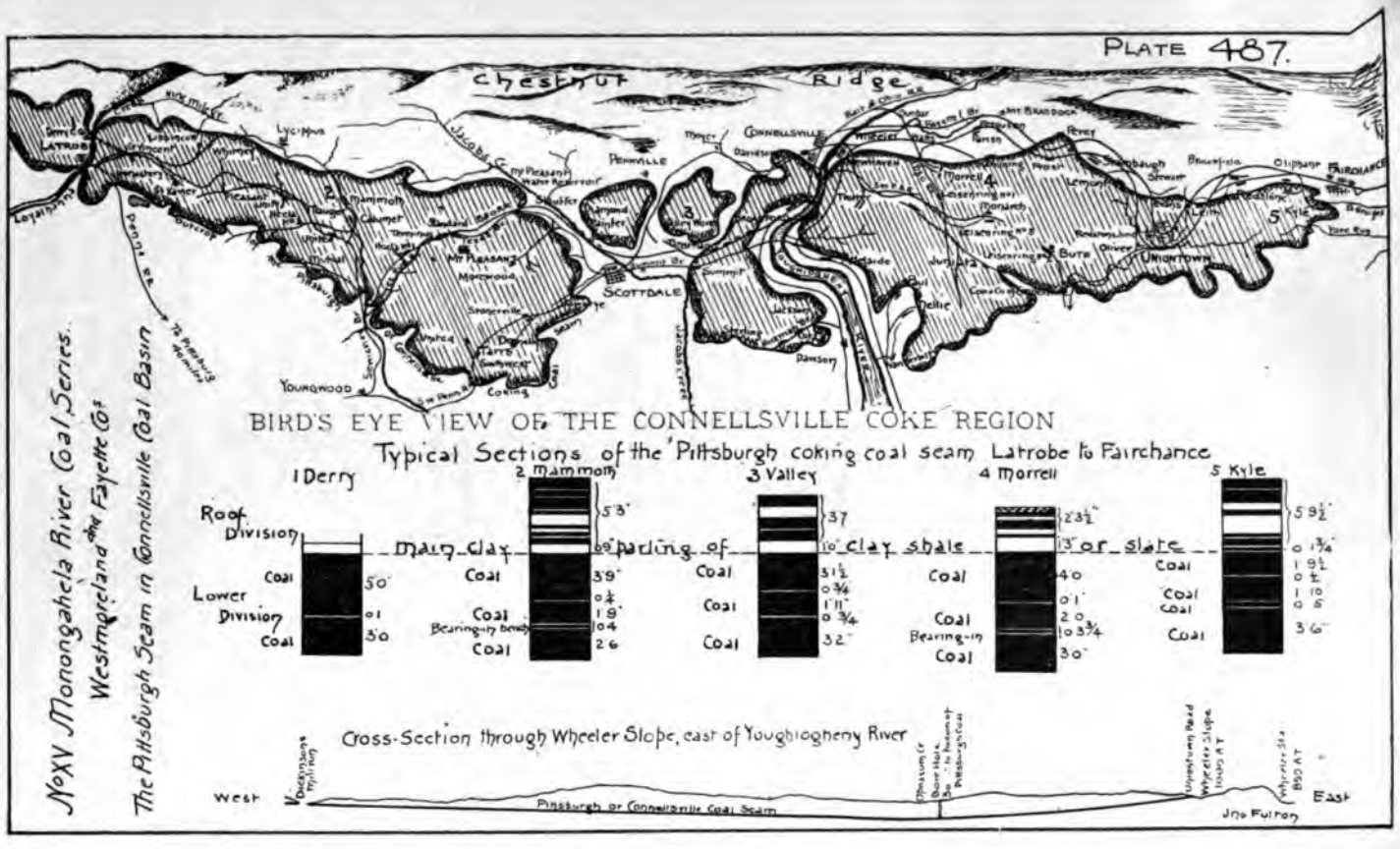


PLATE 487.



BIRD'S EYE VIEW OF THE CONNELLSVILLE COKE REGION

Typical Sections of the Pittsburgh coking coal seam Latrobe to Fairchance

Cross-Section through Wheeler Slope, east of Youghiogheny River

No XV Monongahela River Coal Series.
Westmoreland & Fayette Co's
The Pittsburgh Seam in Connellsville Coal Basin

Its porosity (good cell space) and ability to "stand up" in the furnace have given it a great reputation and fulfill the following essentials of a good blast furnace coke: 1. *Hardness of body.* 2. *Well developed cell-structure.* 3. *Purity.* 4. *Uniform quality.* The average yield in coke from this coal is 65%. Average charge to oven, 48 hour coke, is 120 bushels;* 72 hour coke, 160 bushels. The coal is worked by drift, slope and shaft.† It is estimated that 7 acres of coal will supply 100 ovens for one year. This enormous industry is largely the development of the last 25 years.‡

*A bushel of coke averages 40 lbs. in Penna; a bushel of coal 76 lbs.

†H. C. Frick Coke Co. gave 16,000 ovens in 80 plants in the "*Connellsville District*" in 1890, requiring daily coal production of 1,064,000 bushels; 83 mines (37 drifts, 29 slopes, 17 shafts). Shafts vary from 50' to 542' in depth; slopes 80' to 4000' horizontal depth and some drifts 1¼ miles long. Wagons have a capacity of 34 to 60 bushels; larries 150 to 200 bushels. Some of the mines use mules; others wire rope.

Prevailing system of mining, double heading—pillar and room; rooms 12' wide and pillars 15'; recovering 90% of coal in ground. For complete list of coke ovens (1895) see beyond.

‡The *Connellsville coke industry* practically began in 1859 with the successful trial of this new fuel at the Pittsburgh furnace of Graff, Bennett & Co. Its progress in this basin has been as follows, according to data mainly derived from the valuable reports of Dr. D. T. Day, published annually by the U. S. Geological Survey and prepared by Mr. Jos. D. Weeks of Pittsburgh, Pa:—

In 1860	the number of	ovens was,	70
In 1870	"	"	550
In 1879	"	"	4,220
In 1884	"	"	10,364
In 1893	(in both the upper and lower regions)		19,347

Still more suggestive are the following statistics of production since Census of 1880:

Years.	Coal used. Short tons.		Coke Produced. Long tons.	
	Connellsville.	Upper Connellsville.	Connellsville.	Upper Connellsville.
1880, . . .	3,367,856	319,927	2,205,946	229,433
1890, . . .	9,748,449	889,277	6,464,156	577,246
1891, . . .	7,083,705	1,000,184	4,760,665	649,316
1892, . . .	9,389,549	706,171	6,329,452	451,975
1893, . . .	7,095,491	499,809	4,805,623	320,793
1894, . . .	7,656,169	279,971	5,192,080	176,799

The relationship of the coke industry of the entire state and the balan cc of the country for the years 1880 and 1890 shows:—

States.	Tons of Coke manufactured.	
	1880.	1890.
United States, ...	3,338,300	11,508,021
Pennsylvania, ...	2,821,584	8,560,245
(Connellsville District), ...	2,205,956	6,464,156
Ohio, ...	100,596	74,633
West Virginia, ...	138,755	833,377
Tennessee, ...	130,609	348,728
Georgia, ...	38,041	102,233
Alabama, ...	60,781	1,072,942
Colorado, ...	25,568	245,756
Ilinois , ...	12,700	5,000
Indiana, ...	. . . . .	6,013

In 1880 Penna. produced nearly 85% of this total, Connellsville furnishing about two-thirds and 80% of the Penna. output. In 1890 Penna. furnished 75%, a falling off of 10%, and Connellsville produced three quarters (75%) of all the coke made in Penna.

In addition to the Connellsville district yield, the *Upper Connellsville* or *Latrobe district*, produced 229,433 tons in 1880 and 577,246 tons in 1890, thereby increasing the significance of Pennsylvania's output. In 1895 the estimated tonnage of the present plants in the Connellsville region alone will approximate 8 million tons.

In the years 1891, 1892, 1893 and 1894 the coke production, in long tons, has been as follows:—

	1891.	1892.	1893.	1894.
Connellsville, ...	4,760,665	6,329,452	4,805,623	5,192,080
Upper Connellsville, . .	649,216	451,975	320,793	176,799
Pittsburgh District, . . .	94,160	176,365	216,268	227,100
Pennsylvania,	6,954,846	8,327,612	6,229,051	6,063,777

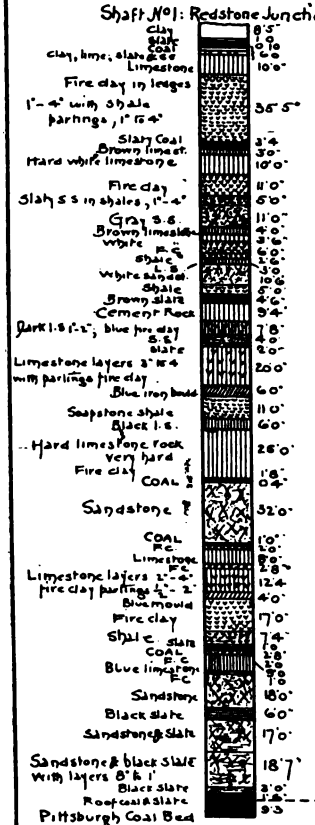
PLATE 488.

No XV Monongahela River Series in the Connellsville Basin

Fayette County

1 Oliver Coke Works

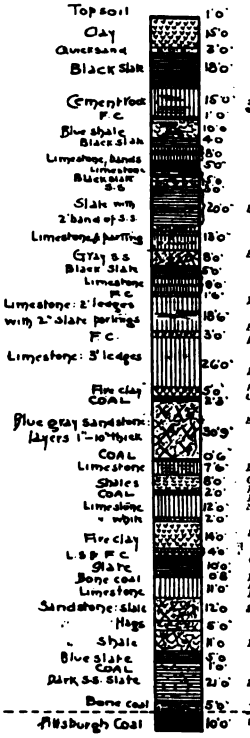
Shaft No 1: Redstone Junction



Total depth 414'8"

2. Leisenring No 1 Shaft

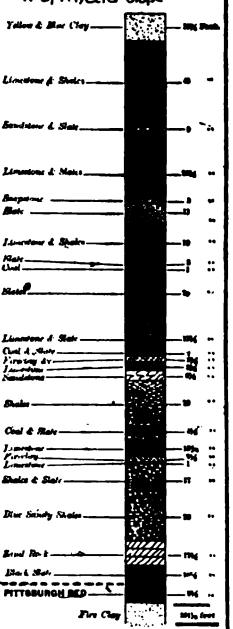
Dunbar Twp: Fayette Co.



Total depth 371'11"

3. Bore Hole Section

W of Wheeler Slope.



E. V. d. l.

A recent revised list of the *Connellsville Region* mines and coke ovens between *Latrobe and Fairchance* is given in the following table:*

The Coke Ovens of the Connellsville Region.

WORKS.	OPERATOR.	OVENS.
Adelaide	H. C. Frick Coke Co.	342
Anchor	Atcheson Coke Co.	100
Atlas	Cambria Iron Co.	80
Bessemer	McClure Coke Co.	278
Buckeye	McClure Coke Co.	160
Calumet	Calumet Coke Co.	225
Charlotte	H. C. Frick Coke Co.	87
Chester	E. A. Humphries & Co.	40
Clarissa	Jas. Cochran, Sons & Co.	108
Coalbrook	McClure Coke Co.	70
Crossland	Atlas Coke Co.	100
Davidson	H. C. Frick Coke Co.	330
Dexter	J. R. Stauffer & Co.	40
Derry	Derry Coal and Coke Co.	182
Diamond	McClure Coke Co.	66
Donnelly	McClure Coke Co.	254
Eagle	H. C. Frick Coke Co.	80
Emma	J. W. Overholt & Co.	86
Enterprise	McClure Coke Co.	51
Elm Grove	W. T. Rainey	64
Fairchance	Fairchance Furnace Co.	141
Fort Hill	W. J. Rainey	126
Foundry	H. C. Frick Coke Co.	97
Franklin	B. F. Keister & Co.	50
Frick	H. C. Frick Coke Co.	105
Grace	W. J. Rainey	408
Great Bluff	E. A. Humphries	16
Hazlett	McClure Coke Co.	261
Hecla No. 1	Hecla Coke Co.	272
Hecla No. 2	Hecla Coke Co.	500
Henry Clay	H. C. Frick Coke Co.	120
Hill Farm	Dunbar Furnace Co.	150
Home	Stauffer & Wiley	20
Hostetter	Hostetter Connellsville Coke Co.	305
Jackson	Jackson Mines Co.	58
Juniata	Juniata Coke Co.	250
Kyle	H. C. Frick Coke Co.	164
Laughead	Martin Coke Co.	50
Leisenring No. 1	H. C. Frick Coke Co.	500
Leisenring No. 2	H. C. Frick Coke Co.	500
Leisenring No. 3	H. C. Frick Coke Co.	504
Leith	H. C. Frick Coke Co.	306
Lemont, No. 1	McClure Coke Co.	234
Lemont, No. 2	McClure Coke Co.	300
Mahoning	Cambria Iron Co.	100
Mayer	H. C. Frick Coke Co.	15
Mammoth	H. C. Frick Coke Co.	510
Mayfield	McClure Coke Co.	104
Morgan	H. C. Frick Coke Co.	165
Morrell	Cambria Iron Co.	400
Mt. Braddock	W. J. Rainey	170
Mullen	McClure Coke Co.	82
Mount Hope	Taylor & Co.	40
Nellie	Brown & Cochran	339
Oliphant	H. C. Frick Coke Co.	152
Oliver No. 1	Oliver Coke & Furnace Co.	339
Oliver No. 2	Oliver Coke & Furnace Co.	300
Painter	McClure Coke Co.	238
Parrish	Dunbar Furnace Co.	70
Paul	W. J. Rainey	417
Pennsville	Pennsville Coke Co.	92
Percy	Percy Mining Co.	62
Rainey	W. J. Rainey & Co.	156
Redstone	H. C. Frick Coke Co.	446
Southwest No. 1	Southwest Connellsville Coke Co.	620
Southwest No. 2	Southwest Connellsville Coke Co.	251

* From the Connellsville Courier of March 1, 1895, with the addition of the *Derry plant* of 182 ovens at Latrobe.

The Coke Ovens of the Connellsville Region—Continued

WORKS.	OPERATOR.	OVENS.
Southwest No. 3,	Southwest Connellsville Coke Co.,	180
Southwest No 4,	Southwest Connellsville Coke Co.,	151
Standard,	H. C. Frick Coke Co.,	905
Sterling No. 1,	H. C. Frick Coke Co.,	100
Sterling No. 2,	H. C. Frick Coke Co.,	294
Stewart,	Stewart Iron Co.,	122
Summit,	H. C. Frick Coke Co.,	142
Tip Top,	H. C. Frick Coke Co.,	121
Trotter,	H. C. Frick Coke Co.,	464
Tyrone,	Laughlin & Co.,	141
Union,	McClure Coke Co.,	70
Uniondale,	Reid Brothers,	74
United No. 1,	United Coal and Coke Co.,	300
United No. 2,	United Coal and Coke Co.,	301
United No. 3,	United Coal and Coke Co.,	154
Valley,	H. C. Frick Coke Co.,	251
West Overton,	A. C. Overholt & Co.,	110
Wheeler,	Cambria Iron Co.,	108
White,	H. C. Frick Coke Co.,	200
Whitney,	Hostetter Connellsville Coke Co.,	302
Wynn,	H. C. Frick Coke Co.,	70
Youngstown,	H. C. Frick Coke Co.,	240
Totals,		18,016

Recapitulation.

	NO. OVENS.	TOTAL WEEKLY TONNAGE.
H. C. Frick Coke Co.,	9,140	80,091
McClure Coke Co.,	2,405	20,348
W. J. Rainey,	1,401	8,300
Hecla Coke Co.,	772	5,650
Cochran and others,	745	7,700
Hostetter Connellsville Coke Co.,	607	6,375
Small Operators,	1,153	10,130
Iron manufacturers making their own coke,	1,793	17,700
Totals,	18,016	156,289

In the *Connellsville region* some of the best and most

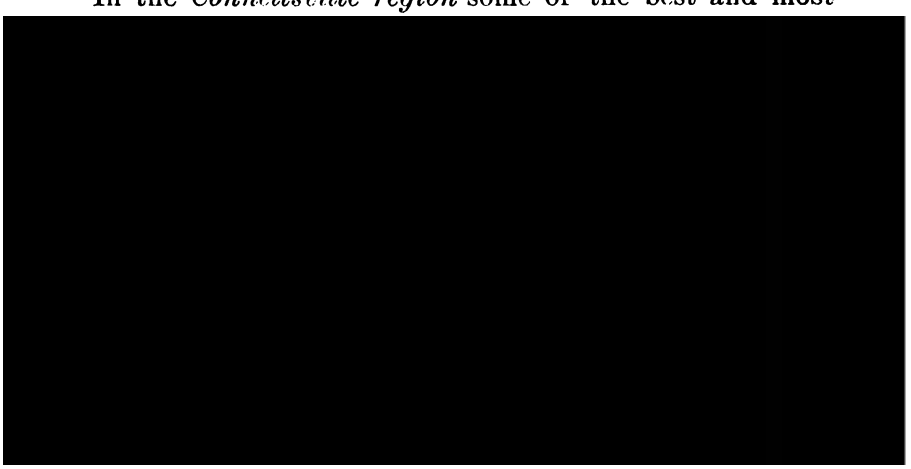
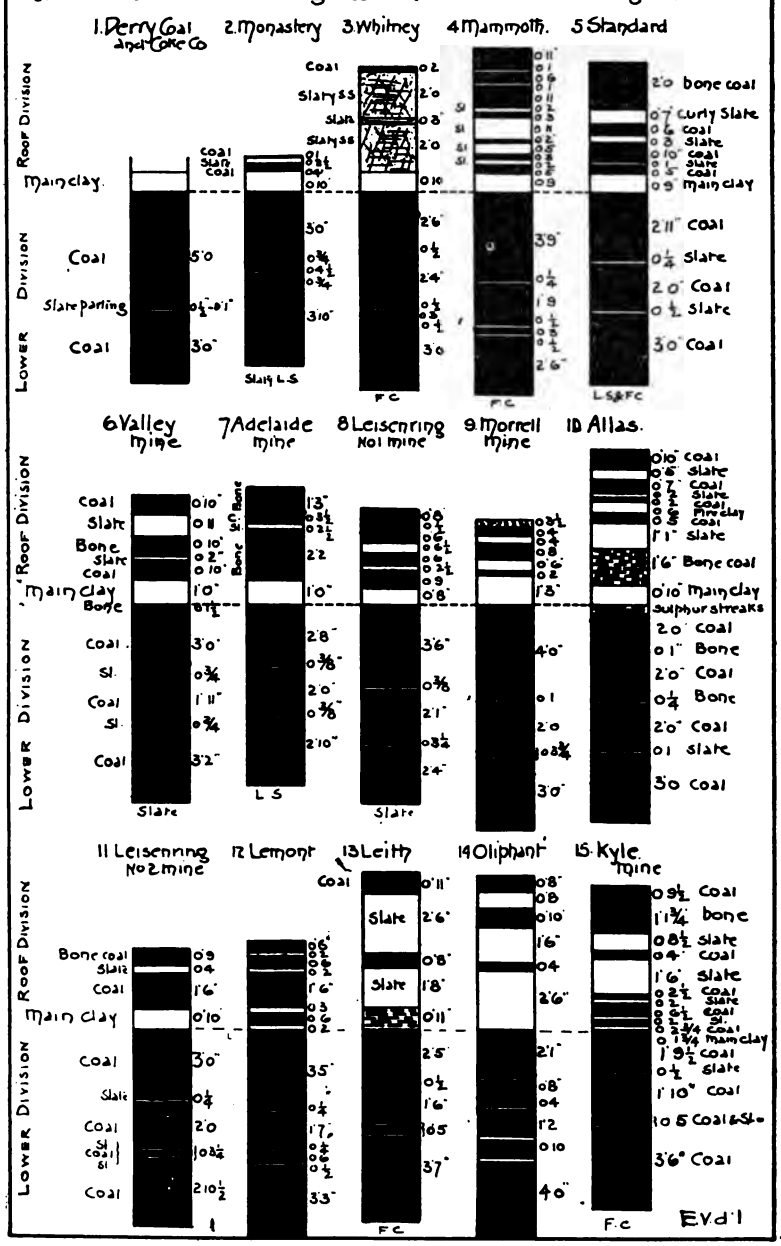


PLATE 489

No XV Monongahela River Series. Westmoreland & Fayette Co's

Vertical Sections Pittsburgh Coal Connellsville Coke Region



angles to insure moderate gradients across the floor of the coal bed; from these the rooms were laid off mainly parallel to the main headings, usually 10′ to 14′ wide, with pillars 8′ to 12′ (See plate 491.) This would frequently entail a loss of 20% to 40%, the pillars when pared down, gradually splintering and crushing in. Now there is a loss of only about 10%, the rooms being driven 300′ and then the pillars removed between them.*

North from the Cheat river the Pittsburgh coal bed is double; but its roof member is here, as in all other basins, *commercially* worthless. Its general average thickness in the various townships covering the basin may be stated in tabular form as follows:

Township.		*Roof Division.*	*Main Clay.*	*Lower Division.*	*Coal in Roof division.*
Springhill,	Fayette County.	4′ 0″	0′ 6″	8′ 6″	1′ 6″
Georges,		4′ 0″	2′ 6″	9′ 1″	1′ 10″
North Union,		. . . .	. . . .	8′ 4″	. . . .
Dunbar,		5′ 1″	1′ 0″	9′ 0′·	3′ 7″
Connellsville,		5′ 1″	1′ 0″	8′ 1″	3′ 7″
Mt. Pleasant,	Westmoreland Co.	4′ 1 0″	0′ 8″	6′ 9″	4′ 4″
Unity,		0′ 6″	1′ 0′	7′ 11″	0′ 6″
Derry: P. R. R.,		0′ 4″	1· 0′	6′ 8″	0′ 4″
Derry: Conemaugh river,		0′ 3″	1′ 3″	6· 1″	0′ 3″

It is curious to find the roof division thickening northward from the West Virginia State Line to the southern line of Westmoreland Co. from whence it decreases steadily before thickening up again across the Conemaugh in Indiana Co., where the divisions are 1′ 11″; 0′ 10″; 6′ 7″ and 0′ 7″. In like manner the lower division is strongly characterized by differences as compared with other basins, though always thick and good.

In *southern Fayette* it carries several thin but scarcely

*Two methods pursued by *Cambria Iron Co.* are illustrated n plate 491. The first consists of hewing coal on face of pillar, protecting miners with double row of props, 2′ to 3′ apart, and the two lines 3′ apart. The second method protects miners by single row of props placed 6″ to 1′ apart, near working-face of coal pillar, the miner attacking on flank instead of end, removing sections 5′ to 8′ in length. It is the safer plan of the two.

perceptible partings, many of them soft mineral charcoal. Sometimes the upper bench (beneath the main clay parting) is triple, and in a large area carries a well marked parting of clay or bony coal at from 27″ to 30″ below the main clay. Toward the north along the Penna. R. R. the bed becomes thinner, and the coal somewhat harder, and the separate benches are better defined without being specially characterized by slate; while in the centre of the basin the whole lower division ordinarily carries but two thin slate binders. (See typical sections plate 487.)

The coal is everywhere regular; *clay veins* and *horsebacks* are rare and when they do occur, are of insignificant size. The chief grievances come in the shape of a poor roof; swells in the soft under clay and from streaks of bony coal which appear and disappear in many mines, mostly in the top bench of coal.

Derry twp. completely encloses the *Blairsville basin*, between the Chestnut ridge and Blairsville axes and the Conemaugh and Loyalhanna. It practically includes all that area of the Pittsburgh coking coal known commercially as the "*Upper Connellsville or Latrobe District*," though formerly this district was extended for some little distance south of the Penna. R. R.

The entire *Upper Productive Series* is exposed here, although its upper members, including the *Great Limestone*, have become insignificant and poorly displayed. (See section plate 492.) None of the coals or limestones

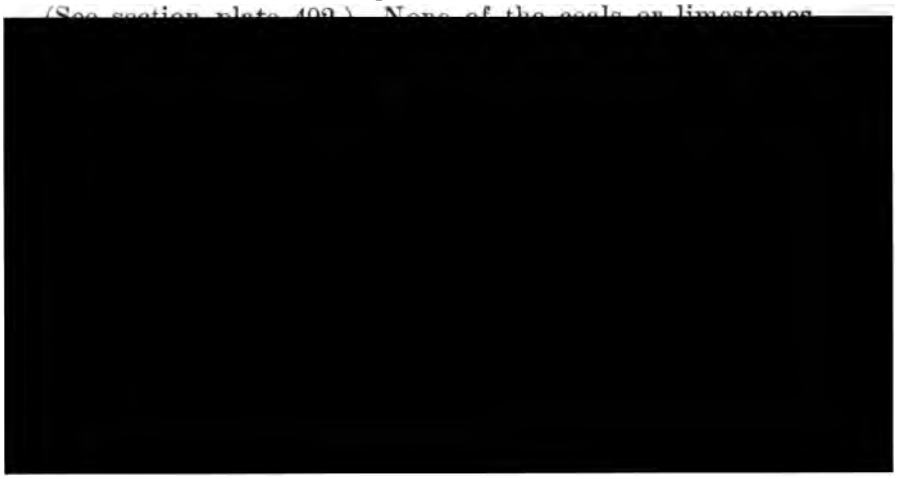
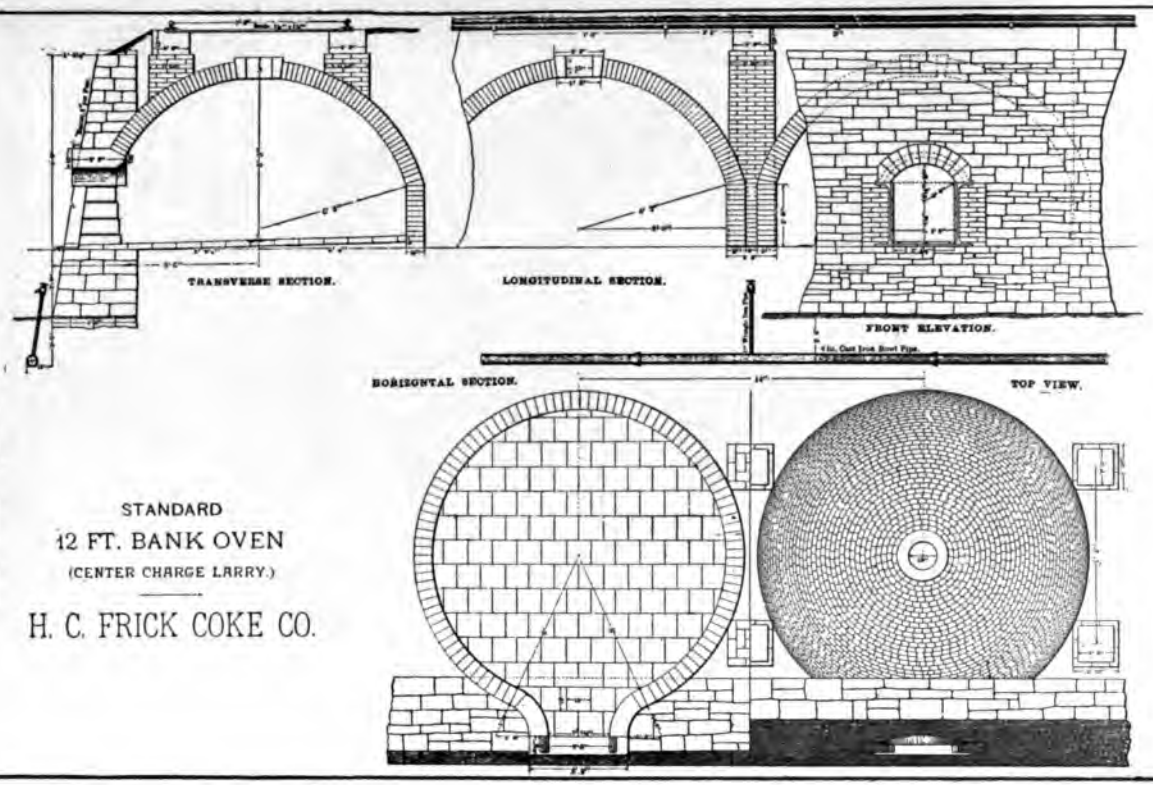


PLATE 490

No XV. Pittsburgh Bed in the Connelsville Region

Bee-hive Coke Oven.



STANDARD

12 FT. BANK OVEN

(CENTER CHARGE LARRY.)

H. C. FRICK COKE CO.

near the centre of the basin, and by *M. Saxman Jr. & Co.* near Latrobe. (Plate 489, Figs. 1 and 2; Derry and Monastery mines.)

In the *Millwood Shaft* a "rock fault," similar to that displayed in the mine of Holstein Bros. 1 mile northeast of West Lebanon in this same basin in Indiana Co., has been met with and successfully overcome, although it caused a serious wash-out and replacement of the Pittsburgh coal. Its average width is 100′ though it has reached 120′ in places; extending more than 1200′ in a direction N 21° E and S 21° W.* rudely parallel to the synclinal axis passing close to Millwood.†

The *Loyalhanna Coal Co's.* shaft occupies an almost similar position in the bottom of this trough 6 miles further south-west on the P. R. R. But the coal there is untroubled, the lower division 8′ thick, without clay veins and few swells in the underclay, though the breast coal occasionally carries 2″ to 4″ of bony coal. The coal is quite soft, only about one-half being lump coal. The slack and nut were formerly extensively coked; but of late the company, after many vicissitudes from fire and drainage, has marketed nearly all of its product as steam coal.

The *Derry Coal & Coke Co.* mine from an adjoining property, their shaft being 115′ deep and the coal 95′ below the level of a small run entering Saxman's run from the northwest of Bradenville. This mine is one of the most regular in the Connellsville basin, and from it during the past 7 years, about 200,000 tons annually have been raised, the

*Similar lagoons or *sand faults* are frequently met with in the Punxsutawney-Du Bois district of Jefferson Co.

† The sides of "rock fault" incline at angles never less than 20°, so that the change is rapid, as the coal bed is quite level. The roof of coal is a grayish clay shale, generally evenly deposited through mine; but at edge of fault, this roof suddenly descends to cut out coal clear to fire clay floor. Near centre occasional wedge-shaped masses of the still higher Pittsburgh sandstone show; but these are exceptional, the faulted area being generally clay shale, which at edges of fault hold small lenticular masses of coal, projecting from main bed, which averages about 8′ thick. Coal near fault badly twisted, hard and compact with little or no lustre, gradually fading away until 400′ away all signs of trouble have disappeared and the bed is normal and shows a most excellent quality, with low sulphur and ash.

lump coal (50%) being separated over a 2″ screen and sent to market for steam purposes, locomotive and rolling mill use, whilst its nut and slack are converted into coke in 182 Bee-hive ovens. The main heading, parallel with the trend or face of the coal, is 3400′ long from which butt entries are driven up the rise of the coal to the eastern outcrop. The main entry has an almost uniform grade of ¾ of 1% in favor of the load, thus rendering haulage* and drainage simple and economical. An average section of the bed shows under a slate roof, an upper roof coal 1′ thick, not mined; breast coal 4′; slate partings ½″ to 1″ thick; lower coal 3′, yielding about 7′ in all. Beneath this there are 2′ of slate and 9″ of fire clay to the limestone floor.

Average analysis of the coal mined from 4 headings and 30 rooms, and the coke produced therefrom show: †

	Coal	*Coke*
Water,	1.049	.030
Volatile matter,	27.842	.458
Fixed carbon,	63.560	88.885
Sulphur,	.914	.802
Ash,	6.635	9.825

As an evidence of the *low phosphorus Bessemer coke* specially made at this plant, the following average of 4 shipments to the Lebanon furnace is given, showing: sulphur .810, phosphorus .0095. Upon comparison with the typical analysis already given at Broadford in the southern end of the basin, it will be seen that the Pittsburgh seam suffers no deterioration in chemical or metallurgical quality

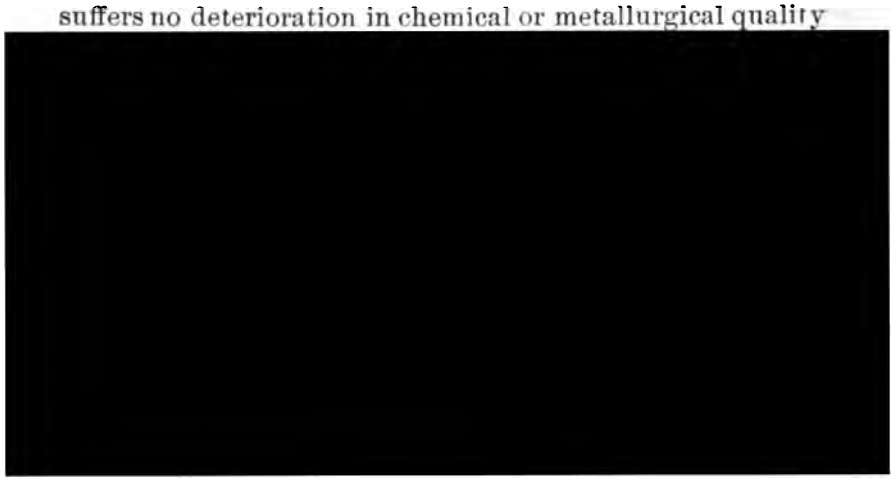


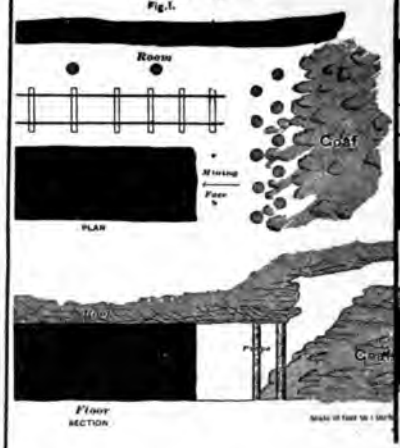
PLATE 491.

No XV Coal Mining in the Connellsville Region

Cambria Iron Co's methods of drawing pillars" Pittsburgh Coal

Jno Fulton M E

Fig. 1.



Jno Fulton M E

Fig. 2.

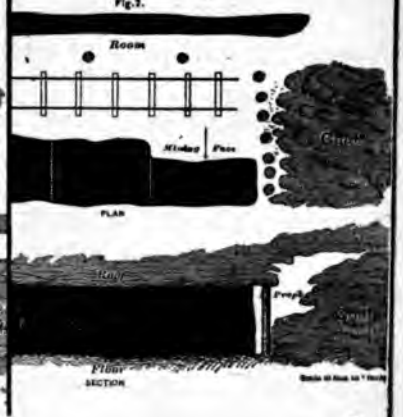


Fig. 3.
PLAN ILLUSTRATING
OLD and NEW METHODS
OF
MINING COAL



On *Lomison's* or *Union run*, numerous openings show, of which the Dr. Lomison pit is typical, with roof coal of 3″; main clay 5″ and the lower division split up as follows: breast coal 4′ 1″; coal and partings 4″; brick coal 10″; coal and parting 3″; clay and shale 10″ and bottom coal 1′ 2″. The thick parting is in the lower bottom and diminishes towards the Loyalhanna.

C. C. Long's farm 1½ miles north-east of Latrobe, shows the following section of the coal: shale roof; coal 1′ 6″; slate 0′ 2″; coal 2′ 6″; slate ½″; coal 2′ 6″.

M. Saxman Jr's mine at Latrobe shows roof coal 4″, separated from the lower division by 1′ of clay. This lower coal division is 7′ 8″, and the parting below the brick coal is barely 1″.

Unity twp. also stretches completely across the basin and extends south to Trauger. Two patches of the *Upper Barren Measures* mark the center of this basin at *Pleasant Unity*, covering the entire Upper Productive Series.

The *Monastery mine*, just south of Latrobe, shows: roof coal in two bands of 1″ and 4″ separated by 2½″ slate; main clay 10″ and bottom division of 7′ 8″, consisting of an upper bench 3′ and lower bench 3′ 10″ with a central band of 4½″, with two slates of ¼″.

---

the bearing-in and two thin bands of slate comprising 4″ about 2′ beneath main clay. Pittsburgh sandstone is only separated from roof by a thin clay parting and it sometimes squeezes the coal to 6′ 6″ which in Noel's bank near by yields 8′ 6″. Roof division seems largely wanting in this district, and coal has prismatic structure and is quite tender.

Near New Derry, mined by Messrs. Breneiser, Walkinshaw and Bennett, with same general section, only roof div. is gradually thickening going north-east until at Coketon, below mouth of McGees run on the Conemaugh, roof div. thins again to 3″; main clay 1′ 3″ lower div. 6′ 1″, partly concealed.

Along western outcrop, on Stony run, mine openings show on the Davis, Donnelly, and other properties, with following general section: Coal 3′ 8″; clay 1″; coal 3″; clay 1″; coal 1′ 10″; clay shale 8″ to 1″ and coal 1′ 6′; total 8′ 2″. It will be noticed that the bed becomes more split up to partake of the character in the West Lebanon field. Top 2′ 2″ of the 3′ 8″ is semi-cannel, with layers of bituminous coal, and thick shale parting at the bottom is pyritous, dividing brick and lower bottom benches, the former decidedly columnar in structure.

The *Pittsburgh coal* shows a great variety of section in this large township.*

The *Lippincott* and *Whitney mines* of the Hostetter Coke Co. are the largest operations in this region and recent careful investigation of the conditions shown there, as well as in the country pits opened on the *Oliver property*, 803 acres, (west outcrop) and *Baggaley property*, 860 acres, (east side) sufficiently illustrate the mining condition and character of coal and coke in large undeveloped areas between the Penna. R. R. and Pleasant Unity.† A typical section of the coal in this part of the field shows an upper coal bench of 5′ 0″; slate parting 0′ 1″, and bottom bench 3′ 0″, yielding about 7′ of commercial coal and leaving about 1′ unmined to support roof.

The *Whitney mine* (see plate 489 fig. 3) shows a lower division of 8′ 2½″ under 10″ of main clay as follows: coal 2′ 6″: slate ½″; coal 2′ 4″; slate ½″; coal 3″; slate ½″; coal 3′. Above the main clay there is 4′ of slaty sandstone and above that 2″ of coal to represent the roof.

An interesting suite of analyses, the average of the results of three independent chemists, each making three determinations from different samples at seven mine openings, gives the following average results, compared with a typical

---

*Vicinity of Lycipus at head of Nine Mile run, eastern outcrop, roof div. 4′ 10″, slaty coal and partings; main clay 8″ and lower div. 6′ 9″. Upper

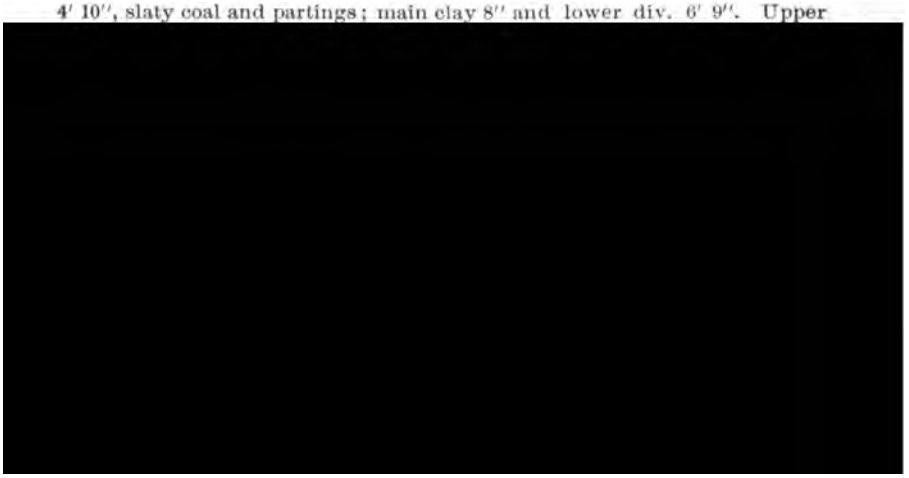
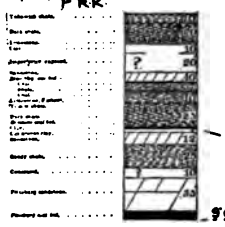


PLATE 492.

No XV. Monongahela River Series w of Chestnut Ridge.

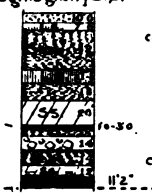
Westmoreland and Fayette Co's

1 Derry twp: Westmoreland P R.R.



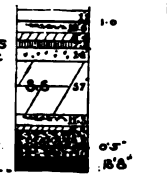
2 ? Hunlingdon twp: Westmoreland

2 Youghiogheny Shaft

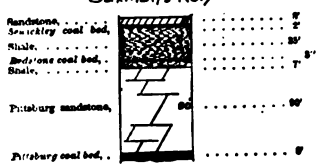


3 Ditto

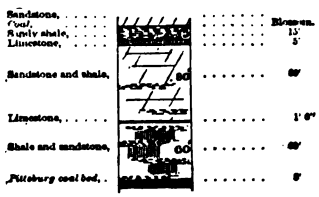
3 Westmoreland Shaft.



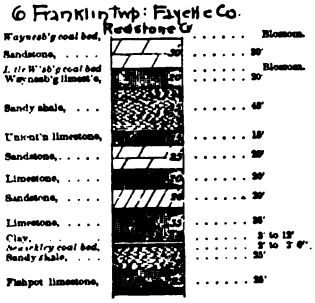
4 Derry twp: Westmoreland Co. Saxman's Run



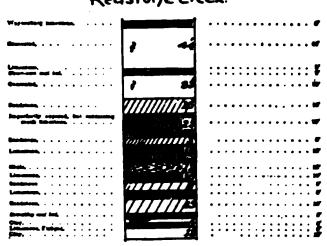
5 Derry twp Bairdstown road.



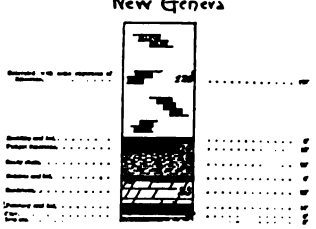
6 Franklin twp: Fayette Co. Redstone Cr.



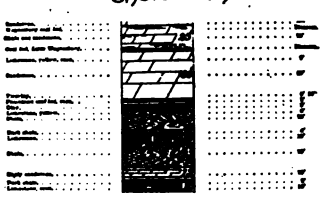
7 So. Union twp. Fayette Co Redstone Creek.



8 Nicholson twp: Fayette Co New Geneva



9 No. Union twp: Fayette Co Shute's Run.



E.V.d'I.

analysis of the Connellsville standard as quoted by Mr. Jno. Fulton:—

Locality.	Water.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phos.	Remarks.
Connellsville Standard.	1.260	31.790	57.790	7.160	.790	.010	Best quality.
1. Ross mine, ...	.701	29.725	59.779	9.457	1.112	.030	Baggaley property.
2. Brindle & Harbaugh,	.672	30.577	59.491	8.854	1.283	.013	Baggaley property.
3. Lippincott, ...	.636	30.453	61.316	7.328	.884	.023	Baggaley property.
4. Whitney, ...	.626	29.670	61.162	8.281	.827	.016	Oliver property.
5. Kintz, ...	.826	31.241	58.855	8.634	1.220	.009	Oliver property.
6. Buck.	.826	29.879	59.095	10.148	.851	.016	Oliver property.
7. McCreary, ...	.700	30.163	57.881	10.937	.996	.012	Oliver property.
Average 7 results,	.707	30.245	59.721	9.022	1.030	.017	

The average character of the coal, as shown by above table, indicates a close agreement in moisture, volatile matter and fixed carbon with the Connellsville standard coal, but exceeds it in ash, sulphur and phosphorus.

Coke made from Lippincott and Whitney Mines Coal.

Locality.	Water.	Volatile Matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
Connellsville standard, .	.490	.110	87.460	11.820	.690	.014
Lippincott, ...	.190	1.720	87.170	10.920	.700	.023
Whitney, ...	.110	3.330	86.420	10.140	.780	.017

The *Lippincott coal* contains .884% sulphur as against .700% in coke, showing the volatilization of 21% in coking. The Whitney has .827% sulphur in coal and .780% in coke, eliminating 18% in coking.

Clay veins are rare in this township. The main clay and floor of the coal sometimes cut out the 8″ bench on top or the lower bottom; but this occasions no loss, as neither bench is ever mined. The coal is tender and brittle, but is decidedly good in character.*

*The *Waynesburg coal* here is slaty and worthless, one opening showing three coal benches each 1′ thick, separated by clay 8″ and 4″; estimated to lie only 280′ above Pittsburgh coal. Neither *Sewickley* or *Redstone coal* amounts to anything, and while the Great Limestone is well shown near Pleasant Unity, 25′ above Sewickley coal, it is neither massive nor very pure, greatly deteriorated in character as exposed in Greene and Washington Cos.

becoming more tender and friable. This lower end of Westmoreland Co., between Jacobs creek (where the coal is eroded) and an east and west line passing through Mt. Pleasant and Bethany contains a large number of openings, amongst which may be mentioned the following: *Standard United No. 2*, *South-west Nos. 1 to 4*, *Donnelly*, *Mayfield*, *Enterprise*, *Union*, *Bessemer*, *Hazlett*, *Mullen*, *Emma*, and *West Overton*.

This large field * of high class coking coal is developed by several small branch railroad lines and is worked by shaft, slope and drifts. The Pittsburgh coal undergoes minor changes of course; but the *Standard mine section* (see plate 489 fig. 5) of the H. C. Frick Coke Co. may best illustrate the average conditions, and is as follows:—

	Black slate		
Roof division	Bone coal	2′ 0″	4′ 2″
	Slate	0 1″	
	Coal	0′ 6″	
	Slate	0′ 3″	
	Coal	0′ 10′	
	Slate	0′ 1″	
	Coal	0′ 5″	
Main clay parting			0′ 9″
Lower division	*Coal*	2′ 11″	8′ 0″
	Slate	0′ ¼″	
	Coal	2′ 0″	
	Slate	0′ ½″	
	Coal	3′ 0′	
	Limestone and fire clay.		

Analysis.†

Water	.300
Volatile matter	31.430
Fixed carbon	60.130
Sulphur	.540
Ash	7.600

A view of this model shaft is given on plate 493, together with a view of the Derry shaft in the north end of the Con-

*The *Waynesburg coal* occurs in the higher hills in central part of trough; always inferior, broken with slate and clay partings. The three other coal beds of series are seen in various parts of county; variable and inferior and never mined commercially. Great Limestone well exposed at Mt. Pleasant, upper (Uniontown) div. being double, lower portion extensively quarried for flux; of good quality, 7′ to 15′ thick; absent north. Lower div. of Great Limestone judged to be 20′ thick; poorly exposed. The Redstone coal occasionally reaches 4′, but is always bony and spoiled by clay veins.

† Chemist J. S. Cary: World's Columbian Exposition, October, 1893. Furnished by H. C. Frick Co.

nellsville field; and of the type of Bee-hive oven used, in plate 490. The coal and coke are both of high character and the plant of 905 ovens easily stamps it the largest and most important individual operation in the district.

Upper and Lower Tyrone twps. of Fayette Co. embrace nearly all the Pittsburgh coal area between Jacobs creek and the Youghiogheny river, consisting of two comparatively small patches along the Bullskin twp. line and a third larger directly between the two streams. About 200′ of the *Upper Productive Measures* are exposed.

The *Pittsburgh coal* has been extensively mined for coking, some of the largest and oldest works being situated in this district, between *Connellsville* and *West Overton.**

Along Jacobs creek are the *Diamond*, *Painter*, *Dexter* and *Charlotte* plants; along the B. & O. R. R. branch the *Home*, *Pennsville*, *Grace*, *Coalbrook* and *Davidson* and along the Mt. Pleasant branch the *Valley*, *Tip Top*, *Franklin*, *Summit*, *White*, *Eagle*, *Foundry*, *Morgan*, *Frick*, *Henry Clay* and *Tyrone*. The *Jackson*, *Rainey* and *Sterling* plants lie to the west.

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* Near Pennville, typical section along eastern outcrop shows: Roof div. 4′ 3″; main clay 0′ 8″; lower div. 8′. Roof carries three coal benches, in all 8′ 7″, of which the upper one, 2′ thick, is equally coal and shale. Lower div. shows top bench 5′ 6″ without parting or binder, frequently seen in mines hereabouts, though in places thin slates are numerous.

The old *Cochran and Kiester opening*, along Dawson—Mt. Pleasant

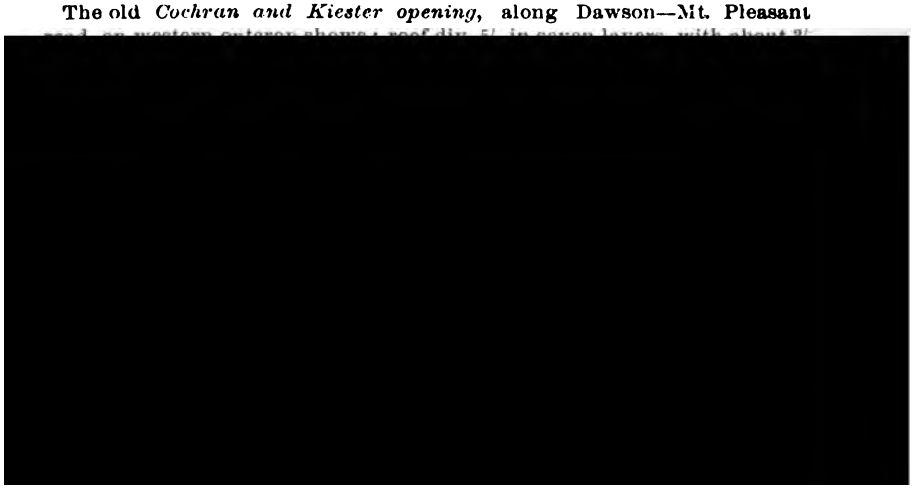
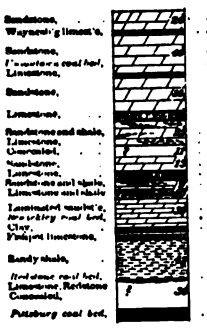


PLATE 494

No XV Monongahela River Series west of Chestnut Ridge

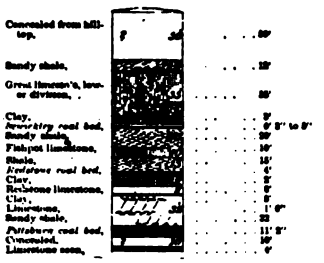
Westmoreland and Fayette Co's

Georges twp: Fayette Co



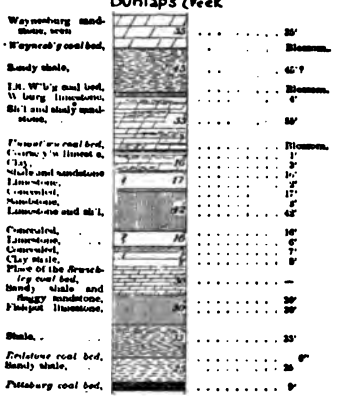
2 Perry twp Fayette Co

Brownfield's Run



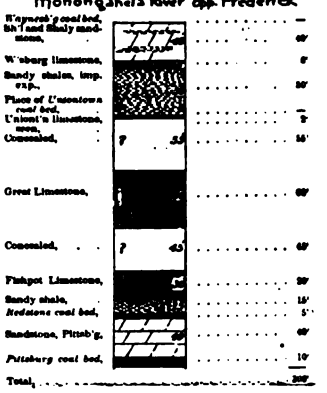
3 Brownsville twp: Fayette Co

Dunlaps Creek

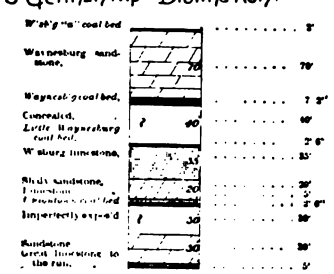


4 Luzerne twp Fayette Co

Monongahela River opp. Frederick

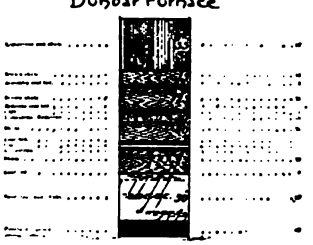


5 German twp Brown's Run



6 Dunbar twp Fayette Co

Dunbar Furnace



E Vd'l



The *Valley mine* shows (plate 489 fig. 6) section and analysis as follows:

Roof division	*Coal*	0′ 10″	3′ 7″	
	Slate	0′ 11″		
	Bone coal	0′ 10″		
	Slate	0′ 2″		
	Bone coal	0′ 10″		
Main clay parting			1′ 0″	
	Bone Coal	0′ 1½″		
Lower division	*Coal*	3′ 0″	8′ 4″	
	Slate	0′ 0¾″		
	Coal	1′ 11″		
	Slate	0′ ¾″		
	Coal	3 2″		

*Analysis.**

Water	.650
Volatile matter	32.050
Fixed carbon	62.550
Sulphur	.400
Ash	4.350

In *Dunbar twp.* three small patches of the *Upper Barrens* on either side of Oppossum run carry the section to 750′ above the Pittsburgh coal; but everything above the *Uniontown coal* is poorly exposed. Along Dickinson's Mill run the western outcrop is indented and the Pittsburgh coal exposed for two miles, from whence it crops along the river nearly to Broadford.

In the vicinity of New Alexandria at the *Clarissa, Nellie, Paul* and *Fort Hill* works the lower division is exposed from 6′ to 9′ thick, with roof coal 3′ 8″; main clay 0′ 5″ and lower division 8′ 0″, with benches of 4′ 0″, 1′ 8″ and 2′ 4″, the bottom 2′ showing binders, not persistent.

The *Adelaide mine*, facing the river, a short distance east towards Broadford, shows a fair type of this *Youghiogheny river district* as follows (plate 489 fig. 7):—

Roof Division	Bone coal	1′ 3″	3′ 11″	11′ 9¾″
	Coal	0′ 3½″		
	Slate,	0′ 2½′		
	Bone coal	2′ 2″		
Main Clay Parting			1′ 2″	
Lower Division	*Coal*	2′ 8″	6′ 8¾″	
	Slate,	0′ 0⅜″		
	Coal	2′ 0″		
	Slate	0′ ⅜″		
	Coal	2′ 10′		

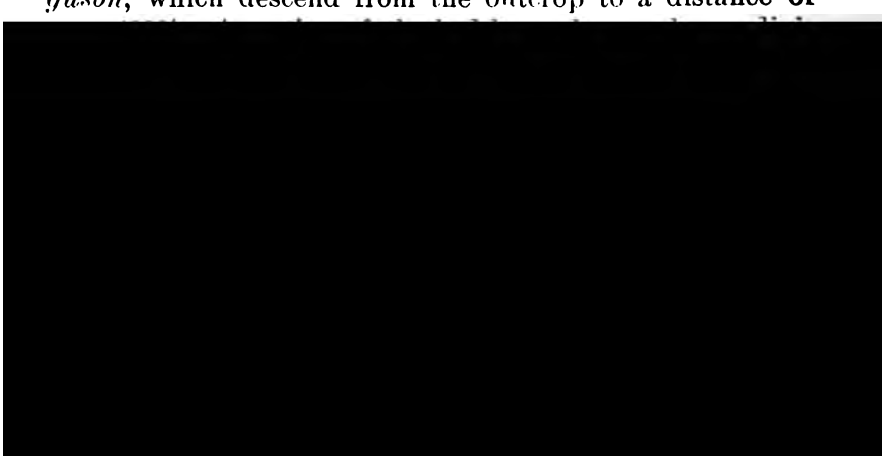
* Furnished by H. C. Frick Coke Co. and J. S. Cary, Chemist. This analysis can hardly be called typical of the region, especially in the constitutents of sulphur and ash, both of which will average nearly twice as high.

Numerous openings show along the eastern outcrop, from *Connellsville* to *Mt. Braddock*, the workable portion of the bed varying from 8′ to 9′. These are the *Trotter*, *Wheeler*, *Morrell*, *Uniondale*, *Leisenring No. 1*, *Great Bluff*, *Anchor*, *Mahoning*, *Atlas*, *Hill Farm*, *Monarch*, *Leisenring No. 3* and *Parrish*.

Average sections at three of these plants show: (See plate 489 figs. 8, 9 & 10.)

	*Leisenring No. 1.**			*Morrell.*†			*Atlas.*†		
							Coal	0′ 10″	
	Bone coal	0′ 8″					Slate	0′ 5″	
	Slate	0′ 0½″		Bone coal	0′ 3½″		*Coal*	0′ 7″	
	Bone coal	0′ 6″		*Coal*	0′ 4″		Slate	0′ 2″	
	Coal	0′ 1½″		Slate	0′ 4″		*Coal*	0′ 2″	
Roof Division	Slate	0′ 6½″	3′ 4″	*Coal*	0′ 8″	2′ 3½″	Fireclay	0′ 6″	5′ 8″
	Coal	0′ 6″		Slate	0′ 6″		*Coal*	0′ 5″	
	Slate	0′ 2½″		*Coal*	0′ 2″		Slate	1′ 1″	
	Coal	0′ 9″					Bone coal	1′ 6″	
Main clay parting			0′ 8″			1′ 3″			0′ 10″
	Coal	3′ 6″		*Coal*	4′ 0″		*Coal*	2′ 0″	
	Slate	0′ 0½″		Bone	0′ 1″		Bone	0′ 1″	
	Coal	2′ 1″		*Coal*	2′ 0″		*Coal*	2′ 0″	
Lower Division	Slate	0′ 1″	8′ 2″	Slate	0′ 1″	9′ 4½″	Bone	0 ½″	9′ 2½″
	Coal	0′ 2″		*Coal*	0′ 2½″		*Coal*	2′ 0″	
	Slate	0′ 0½″		Slate	0′ 0½″		Slate	0′ 1″	
	Coal	2′ 4″		*Coal*	3′ 0″		*Coal*	3′ 0″	

The *Hill Farm opening* of the Dunbar Furnace Co., rendered famous by the disastrous fire of June 16, 1890, is mined entirely for the use of the furnace. The mine is opened by two slopes, the *Hill Farm* and *Parrish* or *Ferguson*, which descend from the outcrop to a distance of



centre of the basin at the head of Henshaw's run, shows the character of the coal to be very different, as follows:

Roof Division	Bone coal	0′ 9″		
	Slate,	0′ 4″	2′ 7″	
	Coal	1′ 6″		
Main clay parting			0′ 10″	
Lower Division	*Coal*	3′ 0″		11′ 7″
	Slate	0′ 0½″		
	Coal	2′ 0″		
	Slate	0′ 0½″	8′ 2″	
	Coal	0′ 2½″		
	Slate	0′ 0¼″		
	Coal	2′ 10½″		
	Limestone.			

Here it will be seen that the roof members have declined in total thickness, while holding nearly the same amount of coal as at Dunbar; and while the total lower division is also a foot thinner, it more closely represents the average character of the bed than the Dunbar section. (Section on plate 489 fig. 11.)

The limestone above the coal has been largely quarried at Dunbar for flux, the *Great Limestone* showing 55′ thick, but a variable mass of limestone and shale, many layers being argillaceous.*

On this same property the Dunbar Co. formerly mined the *Pittsburgh group* of ores, the section being as follows:

	Pittsburgh coal bed	—
Upper Part Barren Measures No. XIV. "Pittsburgh Series."	Clay,	2′
	Ore,	0′ 11″
	Black clay,	3″
	Ore,	3″—4
	Bituminous shale,	1′ 0″
	Clay with *flag ore*,	1′ 0″
	Clay with *lump ore*,	0′ 3″
	Bituminous shale,	1′ 2″
	Flag ore,	0′ 1″
	Not exposed,	16′ 0″
	Limestone,	20′ 0″

* The *Sewickley coal*, double and 3′ to 4′ thick, occurs 15′ lower; interval shale: then 25′ of shale; *Redstone coal* 1′ and limestone 10′; 20′ of shale; 3′ of coal underlaid by clay and limestone 2′; 25′ of shale to a 1′ coal bed and then Pittsburgh sandstone and shale 50 thick down to *Pittsburgh coal.* The latter shows 10 layers in roof, six aggregating 3′ 7″; lower div. varies from

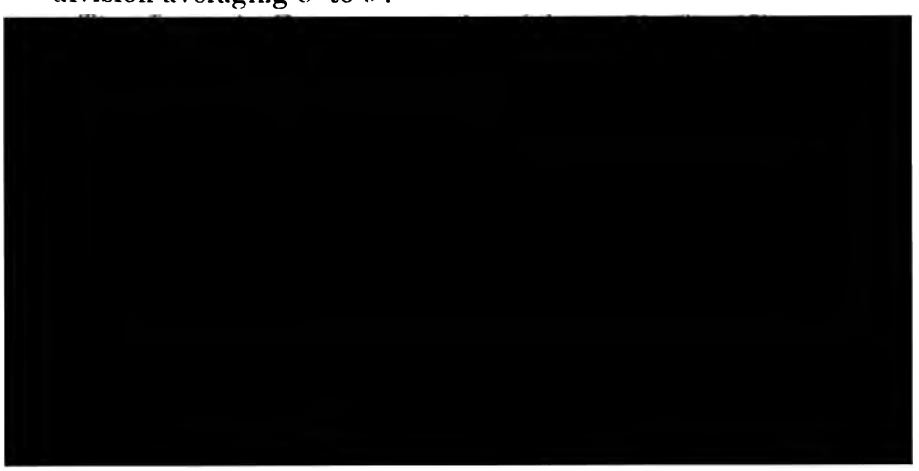
The two upper beds are the ores mostly mined. The top bed ("*Blue Limp*") averages 35% to 37% iron and .006% phosphorus. The next two (*Condemned Flag* and *Big Bottom*) beds yield 28% to 32% iron, and more phosphorus and silica.

North and South Union twps. embrace an important block of the *Pittsburgh* coal and *Upper Productive Measures* extending for a distance of 2½ to 3 miles north and south of Uniontown, west to Jenning's run* and east to the S. W. Penna. R. R. One little patch of the *Upper Barrens* caps the ridge east of the county seat.

The principal mines of this area are the *Percy*, *Youngstown*, *Lemont Nos. 1 and 2*, *Stewart*, *Crossland* and *Leith* along the eastern outcrop and the *Mount Hope*, *Chester* and *Oliver* on the western outcrop and in the basin north of Uniontown.

At Uniontown, the *Uniontown coal* got its name from its good exposure in the cement quarries, showing mainly two benches of 1′ 5″ thick separated by mixed coal and clay 4″. The coal is inferior. Its limestone 10′ thick, and 4′ 6″ below the coal, has been quarried for cement and has obtained a considerable reputation from its use in the locks of the Monongahela Navigation Co. The coal is opened in various parts of this region, but generally worthless. The *Sewickley coal* is 4′ 10″ thick east of Uniontown and quite good.

North and south of Uniontown on the eastern outcrop the *Pittsburgh coal* is opened at many places with a lower division averaging 8′ to 9′.



into four benches of 3′ 5″, 1′ 7″, 0′ 6″ and 3′ 3″, each of which contains thin binders which are not persistent. About 18″ on top is left in for support to roof; the balance is all removed in mining and converted into coke. The *Sewickley coal bed* is found here 5′ thick; the underlying *Fishpot limestone* quarried for flux; the *Redstone coal* 0′ 6″ and two siliceous layers of the Great Limestone. The Pittsburgh sandstone is 40′ thick.

The *Leith mine*, south of Uniontown, shows a still further variation from the normal section, as follows (plate 489, fig 13):—

Roof Division	*Coal*,	0′ 11″		
	Slate,	2′ 6″		
	Bone coal,	0′ 8″	5′ 9″	
	Slate,	1′ 8″		
Main Clay Parting	*Coal* and Slate		0′ 11″	14′ 7½″
Lower Division	*Coal*,	2′ 5″		
	Slate,	0′ 0½″		
	Coal,	1′ 6″		
	Slate,	0′ 0½″		
	Coal,	0′ 4″	7′ 11½′	
	Slate,	0′ 0½″		
	Coal,	3′ 7″		
	Fire clay,			

Along the National road, on the western outcrop the *Pittsburgh coal* shows roof division 2′ 6″; main clay 1′ 2′ and lower division 8′ 6″, with six bands 2′ 10″, 1′ 2″, 1′ 0″, 0′ 4″, 1′ 3″ and 2′ 0″ thick, with thin partings, mostly carbonaceous clay or bone coal. The lower bottom is soft and holds pyrite and is not removed in mining.

In *Georges twp.* next south the *Waynesburg coal* is reached in a few hill summits along the S. Union line, and quite a complete section of the *Upper Productive Measures* was compiled between the township line and Smithfield (See plate 494, fig. 1).

There are several bands of limestone above the *Sewickley coal*, the latter showing two benches 4′ 1″ and 1′ 7″ thick separated by 1″ of clay. The coal here is good fuel, but burns away rapidly, leaving a bulky ash and said to contain considerable pyrite. It has also been worked extensively at the head of Yorks run, in places 5′ 8″. *The Pitts-*

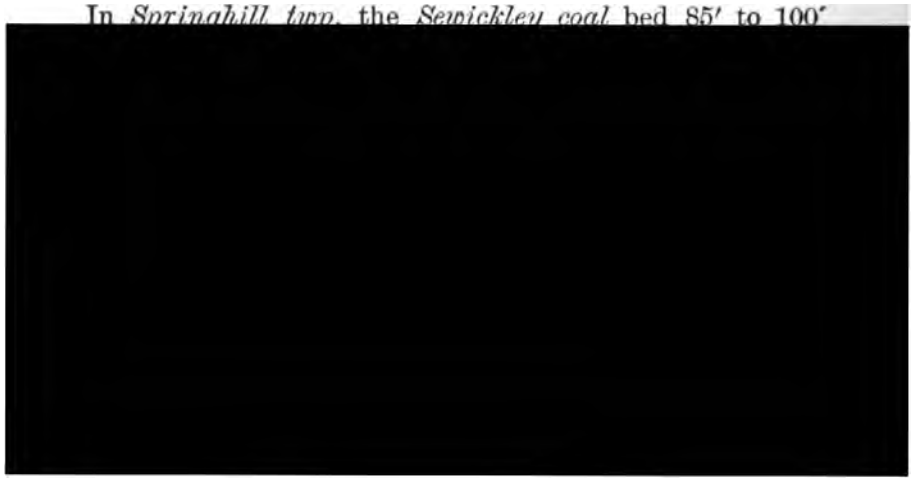
burgh coal rides on to the Fayette axis in this township and spreads east to the S. W. Penna. R. R. and Fairchance, though its two opposing outcrops converge towards Smithfield * where it has only 70′ of cover.

Towards Fleatown in the north-west corner the bed is opened in numerous pits, always of excellent quality, and thence along the western crop to within a short distance of Smithfield.

The *Kyle mine* perhaps best illustrates the character of the bed in this part of the field, the section being as folfows (plate 489, fig. 15):—

Roof Division	Coal,	0′ 9½″		
	Bone coal,	1′ 1¾″		
	Slate,	0′ 8½″		
	Coal,	0′ 4″		
	Slate,	1′ 6″		
	Coal,	0′ 2½″	5′ 9½″	
	Coal,	0′ 2″		
	Coal,	0′ 6½″		
	Slate,	0′ 2″		
	Coal,	0′ 2¾″		
Main Clay Parting			0′ 1¾″	13′ 6¼′
Lower Division	Coal,	1′ 9½″		
	Slate,	0′ 0½″		
	Coal,	1′ 10″		
	Slate,	0′ 0½″	7′ 7′	
	Coal,	0′ 4″		
	Slate,	0′ 0½″		
	Coal,	3′ 6″		
	Fireclay,			

In *Springhill twp.* the *Sewickley coal* bed 85′ to 100′



tween Georges creek and the Cheat river at elevations of 1050′ to 1170′ A. T., while south of the river there is still a good body of coal extending into West Virginia.

The *Sturgis opening*, 1 mile south of Georges creek, shows the Pittsburgh coal with a roof division of 4′; main clay 6″ to 8″ and lower division 8′ 6″. The upper division has two layers of coal, 2′ and 1′ thick separated by 1′ of shale. The lower division has ten small clay partings, from ½″ to 1′ thick, all of which carry sulphur.* The coal benches are all good.

On the Brooks farm near Cheat river, the divisions are 3′, 0′ 2″ and 8′ 4″. The lower division here also carries numerous clay or mineral charcoal partings.

West of Morris cross-roads there are numerous openings on both sides of the road, showing section quite similar, as follows: roof division 2′; main clay 0′ 2″; lower division 8′. Some of these pits take out the entire seam, but the usual yield is about 7′ 6″, leaving some of the bottom coal in.

No. XV in the Greensburg Basin of Westmoreland County.

This irregular shaped basin encloses an area of the *Pittsburgh coal* and *Upper Productive Measures* between the Loyalhanna creek and the County Home south of Greensburgh about 12 miles long and 3 miles wide at its broadest point, narrowing at either end. North of the Loyalhanna, which cuts into the *Barren Measures*, there is a separate area of about 5 square miles of the Pittsburgh coal, with three detached outliers in which no commercial mines are worked, beyond which north to the Conemaugh river only the *Barren Measures* exist. Plate 495 shows the outcrop limits of the coal field, a vertical section of the coal measures and 12 columnar sections of the Pittsburgh coal.

A large part of the coal area in the *Greensburg basin* is yet in the hands of private owners; still large tracts

*Report K 2 page 134.

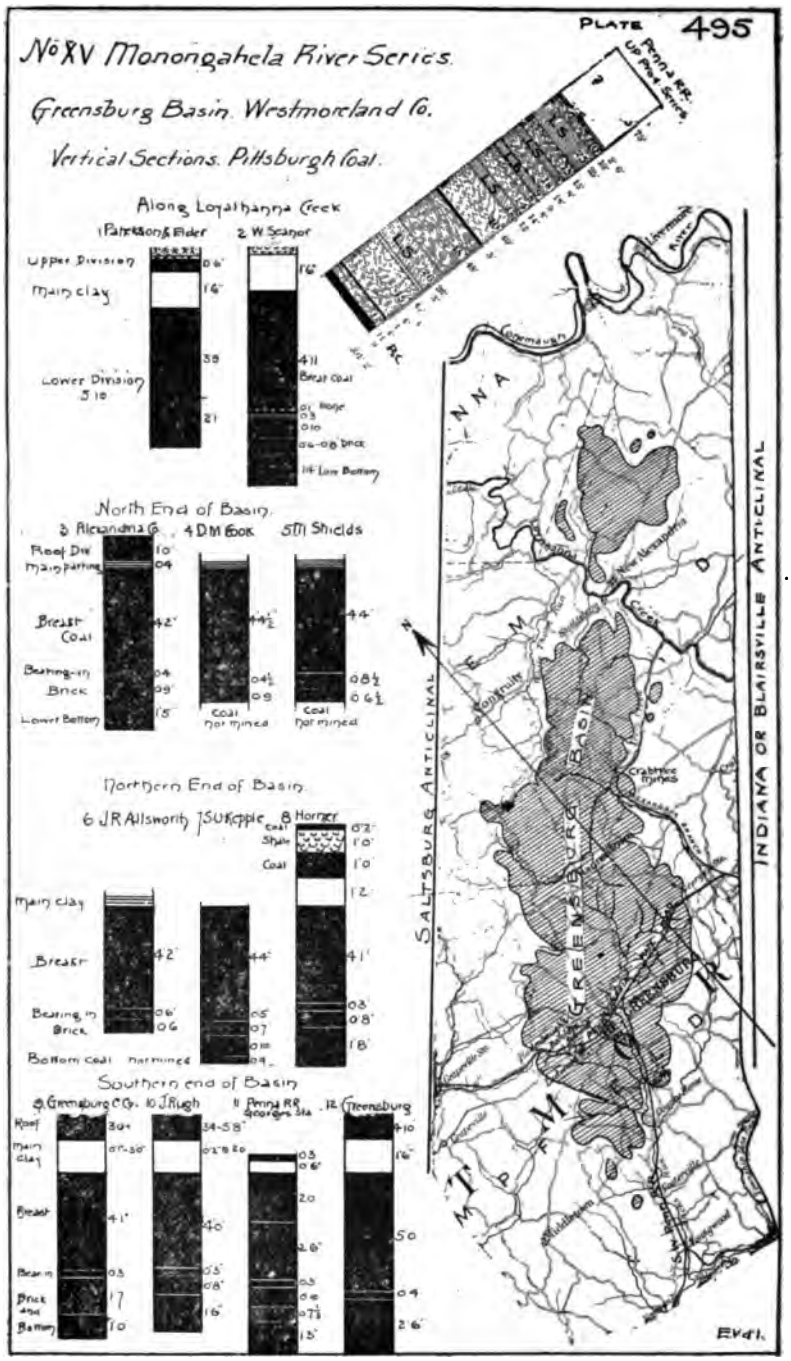
are controlled and mined by the *Carbon*, *Greensburg* and *Hempfield Coal Cos.* in the southern end; the *Jamison Coal Co.* along the eastern side and the *Alexandria Coal Co.* in the north end, while compact bodies of excellent coal land are awaiting development on the west side, owned by Mr. E. J. Berwind and Messrs. Coulter and Huff, north of the Penna. R. R. In all this area the *Pittsburgh coal* varies but slightly, the averages being as follows:

	Top Coal.	Main Clay.	Bottom Coal.	Coal in Roof Division.
Hempfield twp., west side, ...	4′ 10″	1′ 8″	7′ 10″	2′ 1″
Hempfield twp., east side, ...	0′ 4″	0′ 6″	7′ 8″	0′ 4″
Salem twp., ...	2′ 5″	1′ 2″	7′ 7″	1′ 5″
Derry twp., ...	0′ 6″	1′ 0″	6′ 0″	0′ 6″

The roof division is thin on the east side, but always quite thick on the west side; but as it never yields commercial coal, it is of more importance to note the constancy and value of the Lower Division. Here the upper bench or breast coal is usually without partings; but at some of the pits on the east side a parting does occur, which as already seen, sometimes divides this bench in half in the *Blairsville basin* to the east.

The coal itself in this basin is harder than in the Blairsville trough, and while a first-rate all-around fuel, it is not so good for coking as the *Blairsville* (Connellsville) *basin* coal nor for gas making as the *Lisbon* (Irwin) *basin* coal. Physi-




No XV Monongahela River Series.
Greensburg Basin. Westmoreland Co.
Vertical Sections. Pittsburgh Coal.
Along Loyalhanna Creek
1 Patterson & Elder
2 W Scanor
Upper Division
Main clay
Lower Division
Breast Coal
Lower Bottom
North End of Basin.
3 Alexandria Co.
4 D M Cook
5 M Shields
Roof Dirt
Main Parting
Breast Coal
Bearing-in Brick
Lower Bottom
Coal not mined
Northern End of Basin.
6 J R Ailsworth
7 S Ripple
8 Horner
Main clay
Breast
Bearing in Brick
Bottom coal not mined
Southern end of Basin.
9 Greensburg Co.
10 J Rugh
11 Penna RR Georges Sta
12 Greensburg
Roof
Main clay
Breast
Bearing in
Brick and Bottom
Penna RR. Up Print Series.
Conemaugh River
Loyalhanna Creek
New Kensington
Parnassus
Murrysville
Export
Crabtree
Greensburg
Basin
Salt Sburg Anticlinal
Indiana or Blairsville Anticlinal
Evel.

In the 160′ above it there are no less than five bands of limestone 2′ 6″, 25′, 8′, 9′ and 12′ thick, seen in the tunnel cuts of the P. R. R. and S. W. P. R. R. Some of them are quarried, but the 25′ bed yields an impure, somewhat ferruginous rock, and contains a good deal of clay. The balance of this upper section is shale. In the lower half, mostly shale,* there is a 26′ limestone mass near center, commercially worthless but very persistent, consisting of a very coarse, ferruginous limestone and calcareous clay. The lower 45′ shale mass contains two thin streaks of coal, often seen through the basin, generally as a single bed 2′ thick. The *Pittsburgh coal* everywhere presents a good mining section, its lower member, beneath the main clay, being alone worked.

At the *Greensburg Coal Co's.* mines, south of the railroad, it shows a roof division of 3′; main clay parting 3′ to 1″ and lower division 6′ 9″, containing benches of breast coal 4′ 1″; bearing-in 3″; brick coal 1′ 7″ and lower bottom 1′. Sulphur bands occur occasionally, and though the coal is of excellent quality, it is quite brittle. The lower bottom bench is always poor; and clay veins are also met with.†

On the western outcrop openings occur on the Kuhns, Lindsay and Shelly farms, where the roof members have swelled to 4′ 10″ with five clay and coal partings; main clay 1′ 6″ and lower division 7′ 10″, of which the breast coal shows 5′, the bearing in and partings 4″ and brick and bottom coals 2′ 6″. Numerous other openings in this township show slight variations; but the above may be taken as typical.

Salem twp. comprises the upper half of the basin. A

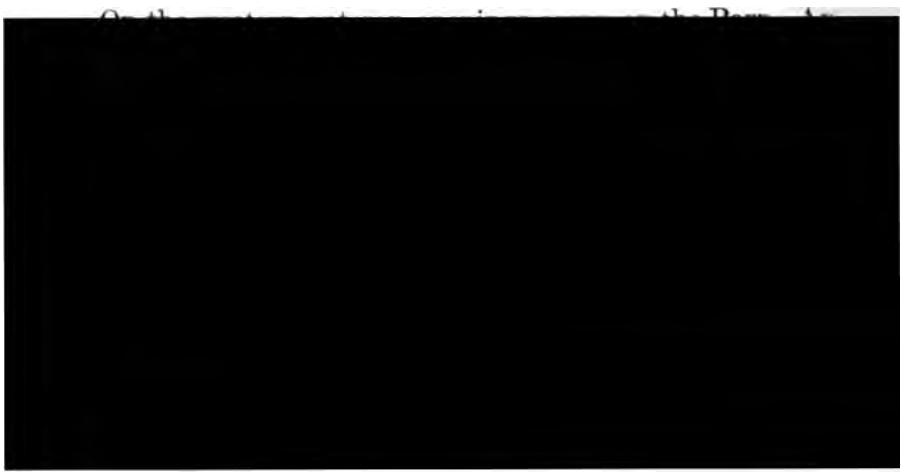
*The Pittsburgh sandstone over the coal is all shale in this basin.

†J. Rugh's mine towards Pleasant Unity shows roof div. 3′ 4″ to 5′ 8″ carrying three bands of coal; main clay varies from 2″ to 2′ and lower div. 6′ 6″, with benches of 4′, 3″, 8″ and 1′ 6″. Along railroad near Georges Station additional variations are noted, upper div. only 3″; main clay 6″ and lower div. 7′ 8″, with benches 2′, 2′ 6″, 3″, 10″, 7½″ and 1′ 3″, both breast and lower bottom holding thin partings, the breast coal parting being rarely present.

number of openings* have been made on both outcrops, that of Mr. Homer's, on the west crop being as follows, and is typical for that side: roof division 2′ 5″; main clay 1′ 2″; lower division 7′ 7″, with benches of 4′ 1″, 3″, 8″ and 1′ 8″. The coal is clean, brittle and shows pyrites in lumps when at all.

The *Alexandria Coal Co's. Crabtree mine* is the largest operation on the east outcrop and one of the most extensive in the basin. The roof division is here 1′ 0″, main clay 4″ and lower division 6′ with benches of 4′ 2″, 4″, 9″ and 9″ to 1′ 5″; the bottom as usual impure. The commercial portion of the bed yields 5′ 6″ to 6′ 0″ of coal, of which about 6″ to 9″ of bottom coal is raised. The breast coal carries 2′ of hard cubical coal on top, the balance being more brittle, falling into slack and used at the coke ovens.†

North of the Loyalhanna the continued north-east rise of the basin carries the Pittsburgh coal into the hills. On the eastern side of the main area the coal is mined by Patterson, Elder and others, the roof division only 2″ thick; main clay 1′ 6″ and lower division 5′ 10″. The breast coal is 3′ 2″ and the brick and bottom together, without parting, show 2′ 4″. No clay veins occur here and horsebacks are rare; the main clay parting however is sometimes only 1″ thick. The upper (breast) bench is thinner here than usual, showing elsewere 4′ 6″.



being peculiar as follows: main clay 1′ 6″; lower division 7′ 11″, with benches 4′ 11″; bony coal 1″; coal 3″; coal 10″; brick coal 6″ to 8″ and lower bottom 1′ 4″; gradually breaking up to its condition on the north side of the Conemaugh in Indiana Co.

No. XV in the Lisbon (Irwin) Gas Coal Basin in Westmoreland Co.*

This wedged-shaped basin is about 22 miles long, between Beaver run and the Youghiogheny river; 10 miles wide in the latitude of the latter, 5 miles along the Penna. R. R. and narrowing down to a point along Beaver run (see plate 496 showing limits of basin, and six columnar sections in extreme north-east end).

The entire *Upper Productive group* shows at but four places between the Penna. R. R. and the Youghiogheny river, where as many patches of the overlying *Upper Barren Measures* still exist, and not anywhere north of the railroad. The average interval between the *Waynesburg coal* and the *Pittsburg coal* is about 350′ to 370′, but still greater towards the south.

The *Waynesburg coal* on top is generally thin but persistent, 3′ thick in S. Huntingdon and still thinner north-east. The *Little Waynesburg coal* is separated from the

*This special district, embracing parts of Franklin, Penn, North Huntingdon, Hempfield and Sewickley twps. of Westmoreland Co., is difficult to limit either graphically or geologically. It joins the northern end of the great *Waynesburg basin* of the south-west and is very well defined *north* of the Youghiogheny river and confined between two straight anticlinals, the *Peters Creek—Roaring Run—Murraysville axis* on the west and the *Grapeville—Saltsburg axis* on the east. But *south* of the river the *Waynesburg axis* gradually develops, apparently out of the very trough of the basin, and increasing in strength towards Bellevernon on the Monongahela, sub-divides the *Irwin basin* to the south-west into the *Waynesburg* and *Lisbon basins*. Geologically this Irwin basin continues to the Conemaugh and beyond and far to the south-west; but the trade name of the "*Irwin or Westmoreland Gas Coal Basin*" still firmly clings to that portion of the trough limited by Beaver run on the north-east and the Youghiogheny river on the south-west, and between the Saltsburg and Murraysville axes enclosing the typical gas coal area of the state, whose coal is not excelled for gas making in the Appalachian region, and forms the standard for all such coals.

upper bed by about 20′ of thin, flaggy sandstone. In Westmoreland Co. it is merely a black shale. The *Waynesburg limestone*, beneath the last little coal, is persistent throughout the Lisbon basin, 10′ thick in Rostraver; 7′ in S. Huntingdon; 5′ thick in Hempfield and N. Huntingdon, and 7½′ in Penn twp., which seems to limit its extent northwards. Between it and the Uniontown coal below the rocks are mainly sandstones and shaly sandstones.

The *Uniontown coal bed*, resting immediately on top of the upper division of the *Great Limestone*, is present in the Lisbon trough as far north as the Penna. R. R. but always thin and of no commercial value.

The *Great Limestone* here shows considerable variations in detail from its characteristics as displayed in Greene and Washington Cos. In the southern portion of the Lisbon trough, in this county, it forms a marked and readily recognized stratum in the measures as far north as the N. Huntingdon line: but followed northwards to the railroad, it becomes shaly and disappears, considerably decreasing the interval between *Uniontown coal* and the lower division of the *Great Limestone*. The lower division* of this *Great Limestone* attains its greatest development in this trough, and extends as far north as the lowest member of the group—the *Pittsburgh coal bed*. However it loses its distinguishing characteristics northwards, and beyond the Penna. R. R. its variations in size and quality are sud-

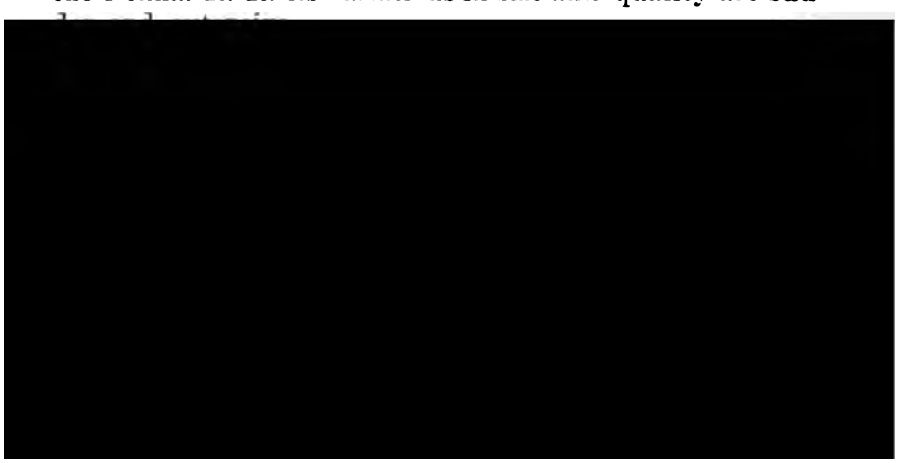
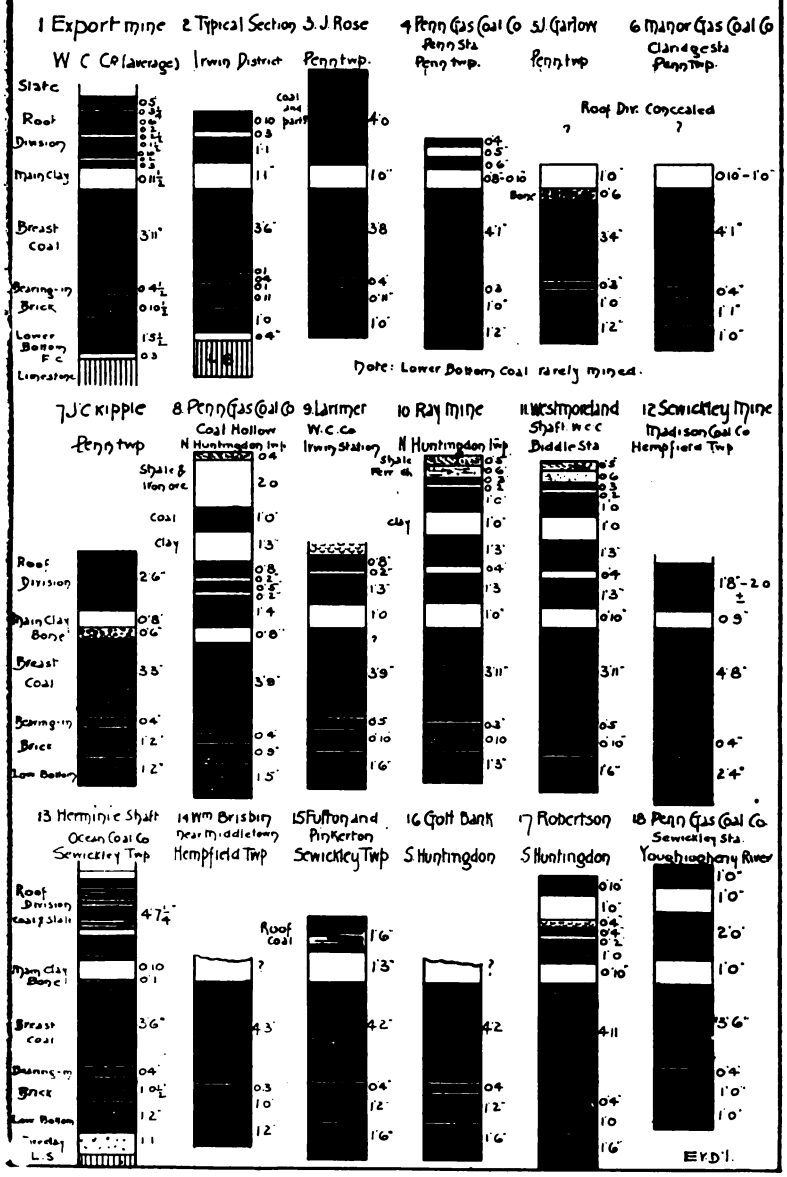


PLATE 497.

No XV Monongahela River Series in Westmoreland Co.

Vertical Sections of the Pittsburgh Coal Lisbon Basin.



The *Fishpot limestone* occurs below the Sewickley coal, with which its relations vary considerably in the Lisbon basin. Its occurrence north of the Youghiogheny river is uncertain and excessively irregular, being present on the east side of the basin as far as Sewickley creek; but it disappears on the west side before reaching Rostraver twp. In S. Huntingdon twp. it is fully 20′ thick, and a limestone of great purity.

The *Redstone coal bed** extends as shale or coal well beyond the Penna. R. R. It is 4′ thick on the Youghiogheny and Sewickley, but thins to 3′ 6″ before reaching the Little Sewickley creek. On the Penna. R. R. it shows 1′ to 3′ thick, at about 80′ above the Pittsburgh coal, and was identified as far north as the Freeport road in Washington twp.

The *Pittsburgh coal bed* at the base is everywhere a large and merchantable seam, of great regularity and freedom from faults. At least at most localities in this trough the roof is good and troubles few in number. *Horsebacks* occasionally occur, most troublesome along the Penna. R. R., where the overlying Pittsburgh sandstone not only cuts out an enormous amount of coal but injures the quality of the coal for a considerable distance on either side. *Clay veins* are of frequent occurrence, some of them wide and of great length. They also usually cause a deterioration in the adjoining coal bed. The bed is continuous under the Youghiogheny river, Sewickley creeks and the Penna. R. R.; but northward its outcrop is deeply serrated and broken down by every stream which crosses the trough, and the coal occurs in patches along the margin, of the field

*Mined to a limited extent, for local use, in Rostraver, S. Huntingdon and Sewickley twps.; while neither very sulphurous or dirty, it is seriously troubled by *clay veins* and *horsebacks*, rendering it a treacherous mining bed. Beneath this coal thin limestone is frequently found, of uncertain and irregular occurrence in the basin in Westmoreland Co. It has, however been identified at various points between the Youghiogheny and New Salem. Interval between Redstone and Pittsburgh coals varies considerably throughout district, but through Lisbon basin, in Westmoreland Co., the gap is largely made up of shaly and flaggy sandstones, some carbonaceous shale, and in places an intermediate thin coal.

yet everywhere maintaining the characteristics of structure it shows in the Pittsburgh region proper (see plate 497.)

In this basin (geologically) the coal is carried northward across Beaver run in an irregular lozenge-shaped area largely owned by the *Saltsburg Coal Co.*, and across the Conemaugh into the Elders Ridge region of Indiana and Armstrong Cos., already described. The structure is curious as will be noted by reference to the tide elevations of the Pittsburgh coal at different points in the basin (plate 496).

The trough enters on the north-east along Thorn run and keeps a pretty straight line for Manor station on the Penna. R. R., dividing the basin into two unequal halves, the west half the larger. Here it trends more south-west until approaching the Little Sewickley; it is abruptly offset to the east, extending in a more southerly direction to Big Sewickley creek near Markle's mill where it again takes up its south-west course to the Youghiogheny at Port Royal.

The Waynesburg axis scarcely makes itself felt north of the river, the Pittsburgh coal riding gently over its creast as it outcrops along both sides of the stream into Allegheny Co.*

The variation of *average bed section* in this area is as follows:

	Top coal.	Main clay.	Bottom coal.	Coal in upper division.
[redacted]				

The roof coal is everywhere worthless, and there is no uniform thickening of the roof division northward, nor in that direction any material increase in the amount of its coal.

The lower division is generally characterized by the same number and arrangement of partings* as in the main coal field along the Monongahela. The coal is of excellent quality, the upper bench of the lower division being hard and firm, and a rich gas coal, and is most highly prized throughout the country for its purity, general excellence and the high illuminating power of its fuel†. (Typical section of bed is given on plate 497 fig. 2).

The coal comes from the mines in large cubical blocks caused by its rectangular cleavage planes, the main one of which is nearly vertical, trending north-east and south-west through the region. This cleavage or "face" of the coal largely determines the course of the mine entries, from which entries are turned at right angles along the "butts" to extract the fuel. The horizontal planes of cleavage are occasionally marked by deposits of soft mineral charcoal, from 1″ to 6″ thick and the vertical planes by scale like deposits of calcite. Sulphur is always present, generally as iron pyrites, in thin flakes and rarely averaging over .7%, though occasionally rising to 1%. Out of scores of analyses made from the enormous shipments of the two largest producers in this basin—the *Westmoreland and Penn Gas Coal Cos.*—the following fairly represents the average char-

*In continuation of Lisbon trough south into Nicholson and Springhill twps. of Fayette and into West Virginia the bed changes somewhat, and structure partakes of Blairsville trough character. Across the State Line the benches are as indefinite as they are in the *Connellsville* or *Ligonier basins.*

†H. C. Adams in pamphlet entitled "*The Gas Coals of the United States*" states that the essentials of a good gas coal are: a low percentage of ash, say 5%; and of sulphur say .5%; a generous share, say 37 to 40%, of volatile matter, charged with rich illuminating hydrocarbons. And it should yield 85 candle feet to the pound carbonized. It should also be sufficiently dense to bear transportation well, and should possess coking qualities that will bring from the retorts, after carbonization, about 60% of clean, strong bright coke."

acter of the Pittsburgh coal here, as well as the typical gas coal of the country:—

	Westmoreland Coal Co.	*Penn Gas Coal Co.*
Water,	1.427	1.280
Volatile matter,	37.521	38.105
Fixed carbon,	54.921	54.383
Sulphur,	.713	.792
Ash,	5.418	5.440

But this standard of excellence is not always maintained through the entire field, nor in these great mines themselves. A suite of seven samples personally taken during the spring of 1892 at widely separated points between New Salem and West Newton showed extremes of water 1.150% and 1.392%; volatile matter 33.247% and 35.510%; fixed carbon 55.628% and 59.040%; sulphur .704% and 1.907% and ash 4.435% and 7.890%. A combination of these 7 analyses gives a coal with the following composition: —

Water,	1.223%
Volatile matter,	34.309%
Fixed carbon,	56.950%
Sulphur,	1.076%
Ash,	6.412%

That very great value attaches to the coal in this part of the basin is evidenced by the large purchases of land here in recent years until at the present time fully $\frac{4}{5}$ths of the entire area as far south as the Youghiogheny river are owned or controlled by large mining corporations*

The *Westmoreland Shaft† operation*, near Manor station



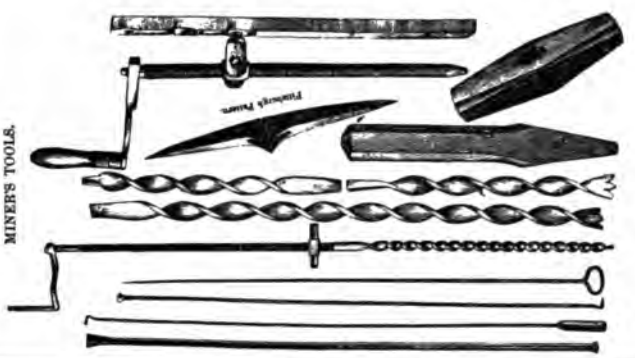
XV. Pittsburgh bed mine machinery.

HARRISON COAL MINING DRILL IN OPERATION.





MINER'S TOOLS.



on the Penna. R. R., is at once the largest and most representative example of the structure and condition of the commercial aspects of the region. This shaft is 190′ deep, with an output closely approximating 1000 tons of lump coal daily, over a ¾″ screen, making about 20% of nut and slack in addition.

In *Loyalhanna and Bell twps.*, bordering the Conemaugh, there is a detached area of the Pittsburgh coal most largely developed by the operations of the *Saltsburg Coal Co.* There are also several smaller patches in Bell twp., where the coal has but little cover.

The *Saltsburg Coal Co's.* operation gives a fair idea of the character of the coal in this area* (see plate 496, fig. 1). The roof division is double, an upper coal 1′ to 3′; clay 2′ and coal 4″, in all 1′ 6″ to 3′ 6″ thick. The main clay parting varies anywhere from 1″ up to 3′, and the lower division 7′ 8″, the whole bed running about 10′ thick. The general structure of the lower division is quite different from that seen further south in the main area. It varies greatly and can only be indicated as follows: Top coal 2′ 2″; parting 1″ to 2′; coal 3′ 2″; parting 1″ to 1′ and bottom coal 1′ 6″. The bearing-in bench is wholly wanting, the middle coal showing no parting; but the other two partings fluctuate widely from 1″ to 2′ or 3′, often displacing the coal above

---

entries, side entries are turned off on the "butts," on double entry system, and from them rooms or mining chambers are developed, the faces of the main slips of the coal being the faces of the rooms. The main entry extends over a mile north-east parallel with the basin, which rises at an average of 1% to 3%. The east side of the basin, as developed by the butt entries, instead of showing a gradual rise to the outcrop, consists of a number of very gently dipping rolls, in both directions, strike and dip, the miners' "hills" and "swamps." Both are frequently accompanied by numerous irregularities in roof and floor, rarely over 2′ in extent, often dislocating, squeezing or warping the coal bed. These imperfections give rise to "*clay veins*," "*spars*" or "*slack veins*" (see plate 504). The courses of those *clay veins* differ and cross each other so that it is difficult to predicate in advance just where they may be met with in succeeding rooms or entries.

* Very similar sections were obtained by Dr. Stevenson at the Anderson, Robinson and Kunkle openings towards Rambaugh's ferry, and at Woolfords on Shaffer's run, where lower parting is more regular, whilst pyrites in these pits spreads more through entire seam. Also along Shaffer's run, where bearing-in bench is distinct and brick coal is from 6″ to 8″ thick.

and below them. The middle coal is sulphurous; thin binders of pyrite also appear in the upper bench; the brick coal is almost cannel, and the lower bottom inferior. The whole bed shows a tendency to columnar structure and furnishes lump coal with difficulty. Notwithstanding its sulphur it bears a high reputation for steam coal, especially for locomotive use.

In *Franklin twp.** the basin has deepened sufficiently to hold nearly 400′ of the *Upper Productive Measures;* but they are poorly exposed and both coals and limestones are thin and unimportant above the Pittsburgh coal seam.†

The *Export mine* of the Westmoreland Coal Co. on Turtle creek is a new but splendidly planned operation and is destined to be one of the largest producers in this portion of the field. The entire bed varies from 10′ 9¾″ to 11′ 2″

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*The new Turtle Creek branch of Penna. R. R. now extends up that creek to Murraysville and into heart of basin at Export, where a new operation of the W. C. Co. is designed to develop a large part of this area in Franklin, along the western side of the basin.

† On Mr. Patterson's property, at head of a little tributary to Turtle creek, the W. C. Co., made a boring to the Pittsburgh bed, of which the following is the record :—

Coal bed,	5″
Limestone,	3′ 3″
Clay,	8″
Sandstone,	7′ 0″
Unknown,	2′ 0″
Limestone,	25′ 0″
Shale,	[illegible]

Westmoreland Co PLATE 499

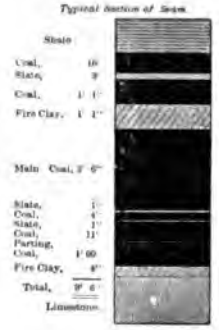
N°XV Monongahela River Series

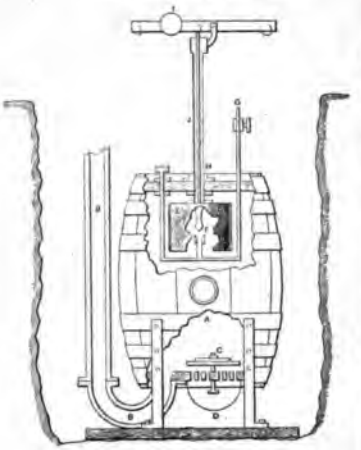
Lisbon Basin

COMPRESSED AIR
WATER ELEVATING DEVICE
Westmoreland Coal Co.

Pittsburgh Coal Bed

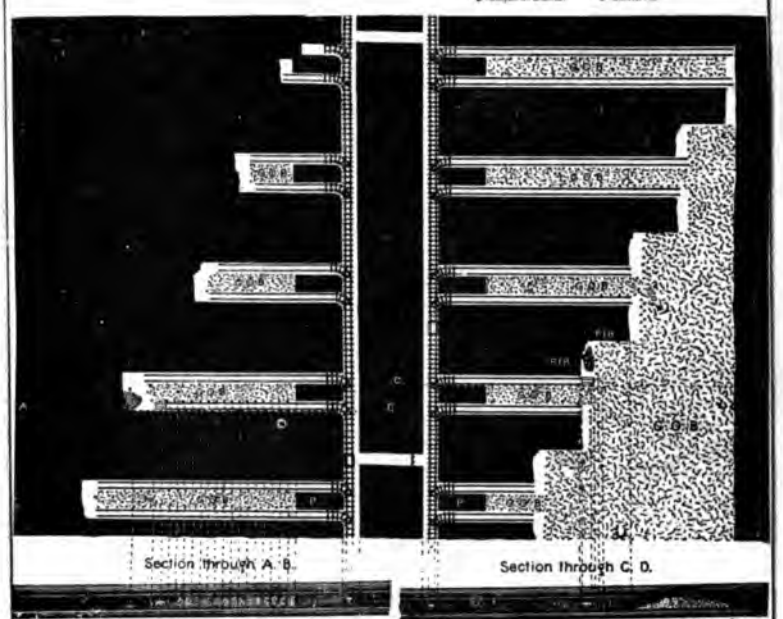
Typical Section of Seam





SECTIONAL VIEW

A—Main Cylinder
B—Exchange Pipe
C—Water Inlet Valve
D—Stream
E—Buoyant Air Chamber
F—Air Inlet
G—Air Supply Pipe
H—Exhaust Valve
I—Regulator
J—Exhaust Pipe



DOUBLE HEADING SYSTEM of WORKING ROOMS and RIBS in the PITTSBURG SEAM. PENN GAS COAL Co

T.F.Wolf

and an average section (see plate 447, fig. 1) recently furnished by Mr. Humphreys Supt., shows a roof division of 3′, containing 5 bands of coal from 3″ to 10″ separated by as many slate partings from 0¼″ to 2″ thick; main clay parting 8″ to 1′ thick; lower division 6′ 6½″ to 7′ 2″. The breast coal bench averages close to 4′; bearing-in and slates 5″; brick coal 0′ 10½″ to 1′ 0″ and lower bottom 1′ 5″ to 1′ 7″, beneath which there are 3″ of fire clay and then limestone. Though not yet thoroughly developed, this colliery has yielded as high as 1600 tons of screened lump coal a day, or over 2000 tons "run of mine." This large output was won entirely by mules, although an endless rope system will soon be inaugurated. The coal is excellent and mines out in large lumps. This colliery will eventually develop 3500 acres of coal.

In *Salem twp.*, north of New Salem and continuing almost to Youngs run, there is an irregular area of the Pittsburgh coal, frequently opened,* where the bed shows only slight variations in structure from the following in the *Hugus and Job pit:* roof coal obscure; one or two layers of coal; in all 10″ to 1′ 3″ thick; breast coal 3′ 11″; bearing-in and partings 4″; brick 1′ 2″ and lower bottom 1′. The top 5″ of breast coal is bony and the bottom bench worthless, leaving 4′ 8″ of available coal to represent the commercial value of the bed in this region.

In *Penn twp.* along Lyon's run the coal is opened at numerous places. This township is the seat of some of the largest operations in the county and is largely owned by the Westmoreland, Penn and New York and Cleveland Gas Coal Cos. on the west side, while considerable areas on the east side of the basin are controlled by the *Manor*, *Claridge*, and *New York and Westmoreland Coal Cos.*

---

*The Stout mine, in small area between forks of Beaver run, shows a roof div. 2′, largely soft coal but impure; main clay 1′ 3″ and low. div. 2′ 9′, with benches 4′ 11″, 4″, 10′ and 1′ 6″. North of Peters run, in Saltsburg area, close to Bell twp. line, character of coal is shown in Jones opening to be: Roof 1′; main clay 1′; low. div. 7′ 9″, with benches of 5′, 3′, 1′ and 1′ 6″. The bed is regular and the coal clean.

The general structure of the bed is shown by the following sections: (See plate 497 figs. 3, 4, 5, 6, 7.)

	Roof.	*Main Clay.*	*Lower Division.*	*Benches of Lower division.*			
J. Rose, ...	4′ 0″	1′ 0′	6′ 0″	3′ 8″	4″	11″	and 1′ 0″
H. Barnhart, . .	. . .	1′ 0″	6′ 0″	3′ 9″	4″	11″	" 1′ 0″
Penn Gas Coal Co., .	1′ 3″	8″ to 10″	6′ 6″	4′ 1″	3″	1′ 0″	" 1′ 2″
John Garlow, ...	. . .	1′ 0 ·	6′ 4 ′	3′ 10″	3″	1′ 0″	" 1′ 2″
Manor Gas Coal Co., .	. . .	10″ to 1′	6′ 6″	4′ 1″	4″	1′ 1″	" 1′ 0″
J. C. Kipple, Boquette,	2′ 6″	0′ 8″	6′ 6′	3′ 9″	4″	1′ 2″	" 1′ 2″

The two first are along Lyon's run. The Barnhart pit shows clay veins in the bed about 1′ wide, with a north-east and south-west course. They extend from the under clay to the roof, curling and twisting the adjacent coal and rendering it inferior for several yards.

The *Penn mine*, near railroad on eastern side, shows a typical section also of the Westmoreland shaft area, both mines furnishing a most excellent gas coal.* Both mines show regular coal for the most part, but variations of roof

*Mr. A. N. Humphreys, Supt. Westmoreland Coal Co., has made a valuable contribution in Ann. Rep. 1886 pages 411 to 456 to the geology and mining practice of the Irwin district, illustrated by several plates of mine maps, machinery, clay veins, etc. some of which have been reproduced for this Final Summary. A typical section of the Pittsburgh coal in this district is shown on plate 499. He attributes the occurrence of *clay* and *slack veins* to slight changes in elevation of the coal bed, after the original plastic mass had become cooled and solidified, and regards them both as having a com-

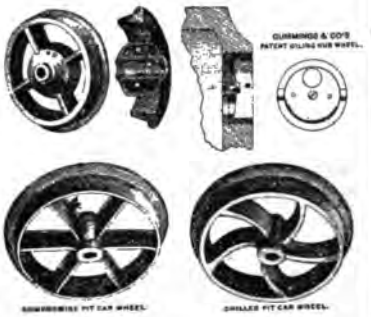
PLATE 500

No XV Pittsburgh Region. Mine Machinery.

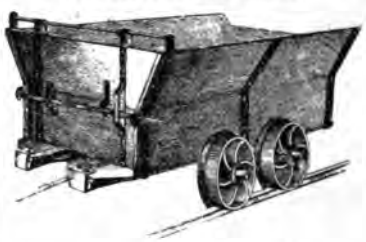
MINE CAR WHEELS.

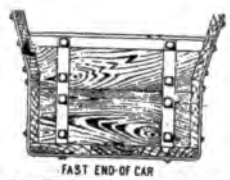
"CHANNEL" OILING HUB WHEEL



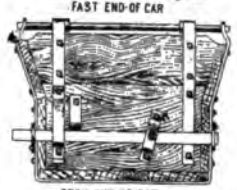


DRAWING OF MINE CAR
USED IN PITTSBURGH REGION.



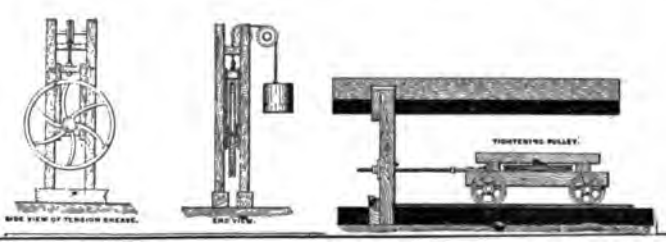


FAST END OF CAR



OPEN END OF CAR





and clay veins, the main clay parting varying from 3″ to 1′ 3″, frequently replaced by hard black shale. The clay veins and horsebacks adversely affect the coal, one in the Penn mine injuring the coal on each side for 8′ and one in the Westmoreland mine, sometimes 6′ wide, running for several hundred yards, and then split up into several branches, which though thinner than the main mass, seem to have done more injury to the coal. In the Garlow opening, south of the Hannastown road, the breast coal bench 3′ 10″ thick, carries 6″ of bony coal on top, and there is a 2″ parting beneath the bearing-in bench.

The *Manor Gas Coal Co's.* opening is an extensive slope, the dip of the coal into the basin being displayed by the grades of the slope; 6½′ per 100′ for 800′; 5½′ per 100′ for the next 700′ and then about 3½′ per 100′. The commercial coal averages about 5′ 6″, and is of excellent quality. Harrison City practically marks the centre of the basin here. The *Kipple mine* at Boquette mill also shows 6″ of bony coal on top the breast bench, the lower bottom poor here as elsewhere.

In *N. Huntingdon twp.* the entire Upper Productive Series is exposed just south of the Penna. R. R. at Irwin. In Coal Hollow, north of the railroad, one of the Penn Co's. mines shows this section of the Pittsburgh coal: roof division 7′ 4″, with four thin bands of coal; main clay 0′ 8″ and lower division 6′ 3″. The *Larimer mine* of the Westmoreland Coal Co., (Plates 505 & 506) only a mile south, shows a remarkable variation in the roof member, here 2′ 1″, and containing only 1′ 11″ of coal as against 3′ 5″ total coal in Coal Hollow. The main clay parting at Larimer is 1′ and the lower division, with great regularity 6′ 6″, with benches of 3′ 9″, 5″, 10″ and 1′ 6″; the breast coal bench carrying a thin but persistent parting 7″ from top, containing pyrites. Pyrite however is present in small quantities in this coal, except in the lower bottom, which is worthless and not mined. The coal has a semi-cannel structure, due to thin streaks of bright bitumen, with a slight tendency to cake, mining readily and bearing transportation well.

Penn Shaft No. 2 south of Irwin* shows the character of the measures for 175′ above the Pittsburgh coal (see plate 492 fig. 2) which here shows a roof division of 4′; main clay 10″ and lower division 6′ 4″, with its usual partings, and greatly troubled with clay veins.

Penn Shaft No. 1 along the Penna. R. R. east of Irwin is 96′ deep, showing a trace of the Redstone coal 65′ above base of Pittsburgh coal and the latter 12′ thick, roof division 4′; main clay 1′ and lower division 7′. Further east is the *Shafton mine* 150′ deep and one mile further the *Westmoreland shaft* 188′ deep, on the eastern slope of the basin where the roof coal benches are 2′ 1″ and 2′ 7″ separated by clay 1′ 2″, the main clay 10″ and lower division 6′ 6″, with benches 3′ 11″, 5″, 10″ and 1′ 6″, the latter not mined. The coal soon crops to the east.

Sewickley and S. Huntingdon twps. embrace all the rest of the coal in the *Irwin basin proper*, down to the Youghiogheny river, except a small area along the eastern rim in Hempfield twp. The principal mining operations have been hitherto confined to the Youghiogheny river valley; but the recent construction of the P. R. R. Hempfield branch down Little Sewickley creek has led to the opening of the large mines of the *Madison Gas Coal Co.* and *Ocean Coal Co.* at Herminie on the east side, the latter near the centre of the basin.

The *Sewickley mine* of the Madison Coal Co. is developed

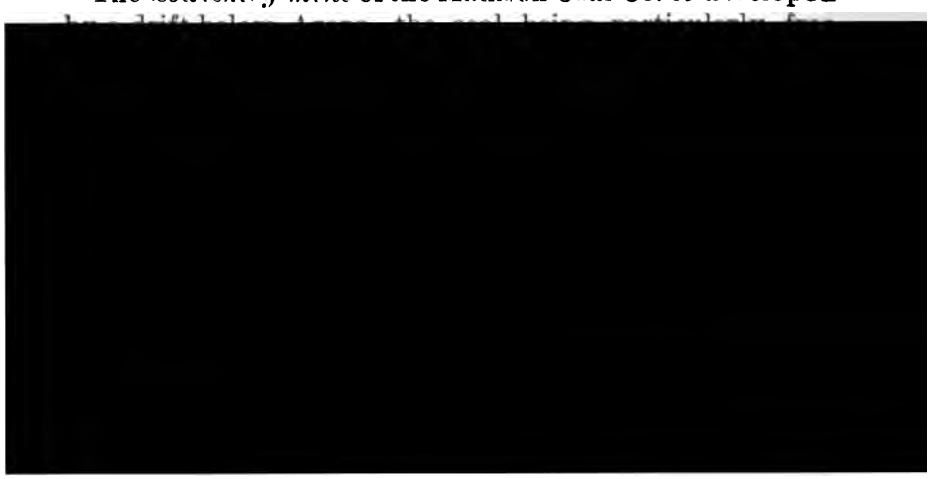


PLATE 501

XV. Pittsburgh bed mine machinery.





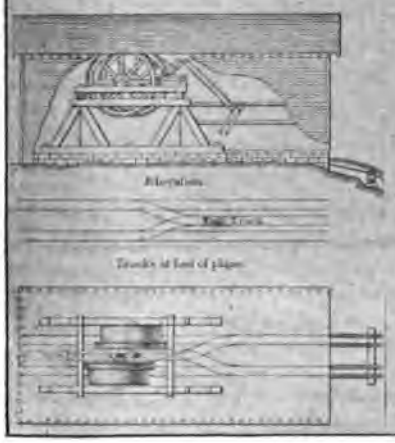
FRONT ELEVATION

TRUCK AND BUCKET
FOR SHAFT SINKING



SIDE ELEVATION

INCLINED PLANE,
TRACKS AND MACHINERY.



EQUIPMENT FOR SLOPE CARRYING
SUPPLIES INTO THE MINE.



not over 4′; but here the brick and portion of bottom bench, in all 1′ 6″ is mined. The average yield is 5′ 6″.

The coal is well prepared and clean, and should yield less than 1% sulphur and 7% ash. Whether this coal, as formerly maintained, does not yield as large a percentage of volatile hydrocarbons as the standard Westmoreland and Penn coals, or whether the gaseous contents are as highly illuminating, can only be determined by retort tests, not at hand; but there is nothing in the physical character of the coal or freedom from visible impurity to render any doubt as to its bearing transportation well and proving a pure and satisfactory gas coal. As mined the coal yields about 80% lump over ¾″ screen, and 20% small nut and slack.

The new *Herminie shaft* of the Ocean Coal Co. on Little Sewickley creek near the heart of the basin is designed to develop a large portion of the Berwind lands in this part of the field. A complete vertical section of the Pittsburgh seam * is of great interest as showing the typical character of the bed in this central portion of the field (plate 497 fig. 13.) The roof division is greatly parted 4′ 7¼″ thick, with no less than 21 bands of coal and slate, the thickest coal bench near the bottom being 10″ and the whole mass being worthless for mining purposes. The main clay parting averages 10″ and the lower division 7′ 4¼″ of which the breast coal bench is 3′ 6″ with an additional 1″ of bone on top; the bearing-in coal 4″ with slate bands above and below of ½″ and ¾″; the brick coal 12½″ and bottom coal 14″, with a ½″ slate between. The mining coal consists of the first three benches, yielding about 4′ 10″ of commercial coal. The mining shaft is 285′ deep, rail to rail, and coal 653′ A. T; but the bed is only about 200′ beneath level of Little Sewickley creek. The workings have been extended about 2000′ north, east and south, but have not yet found any well defined edge to the eastern side† of the basin, so

* Furnished by Mr. William Bainbridge, foreman.

† The William Brisbin bank, 1 mile northeast of Madison, averages 5′ 6″ of coal, breast 4′ 3″ bearing-in 3″, brick 1′ and lower bottom (not mined) 1′ 2″ The Ezra Highberger pit, to the south on Big Sewickley, gives further evidence of integrity and value of the bed on this side of the basin, the en-

that drainage is still uneven. A drill hole 500′ north of shaft, started at 891.42′ A. T. struck the coal at 646.82 A. T.; in which nearly 100′ of limestone was developed in four bands of 12′, 44′, 30′ and 12′, without any evidence of either the Sewickley or Redstone coal beds.

Along *Big Sewickley creek* the Sewickley coal shows above Bells mills, 2′ 6″ of carbonaceous shale directly under the Great Limestone (perhaps 35′ thick), and the Redstone coal 4′ thick. The coal is good, but troubled with bad clay veins and horsebacks. At Markle's mill it is under water level, but it has been cut in bore holes 82′ above the Pittsburgh coal, the latter showing a roof division here 2′ 3″; main clay 1′ 1″ and lower division 6′ 11″.

The western outcrop, south of the P. R. R., spreads west to the South Versailles twp. line and south to the river along the Sewickley twp. line, closely hugging that stream, and opened in a number of places as far south as Sewickley creek, where it disappears beneath water level at 800′ A. T., but still falling up the river to 707′ A. T. at West Newton and 606′ A. T. at Port Royal in the bottom of the basin.

The *Penn Gas Coal Co's.* "Youghiogheny Mine No. 4" at Sewickley station on the B. & O. R. R. is the most extensive plant at this end of the basin, extending for over 2 miles underground up the Little Sewickley. Its coal section is typical for the region as follows: roof division 4′, with two benches of 1′ and 2′, separated

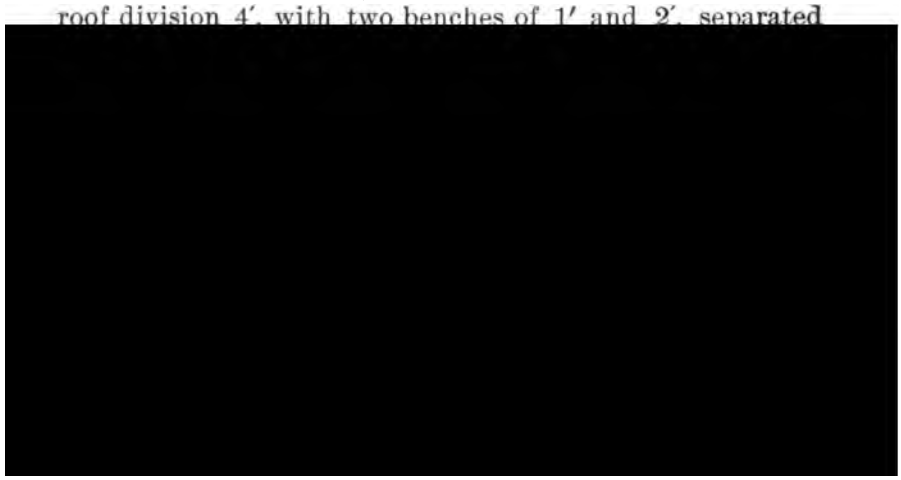
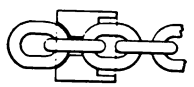


PLATE 502

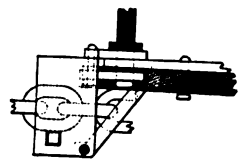
XV. Pittsburgh bed mine machinery.

WIRE ROPE HAULAGE
AT
LARIMER COLLIERY.

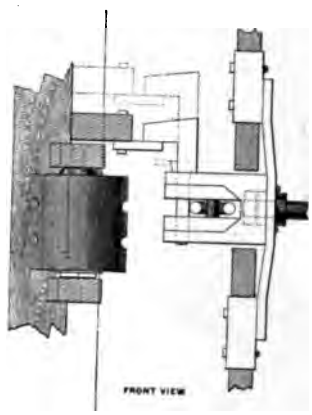
DETAIL DRAWING
SHOWING
CLUTCH & CONNECTIONS.



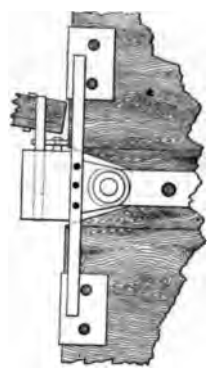
HORIZONTAL SECTION OF CLUTCH AT CHAIN



SIDE VIEW AND PART SECTION



FRONT VIEW



TOP VIEW

Mine Car Hitchings.



Stuff Hitching



Stuff Hitching.



Hook and Cleek Hitching.



Chain and Cleek Hitching.



Chain Hitching.

Penna. R. R. The commercial thickness of the bed here averages about 5′.

At the *Youghiogheny Slope mine* the commercial portion of the bed shows 4′, 4″ and 1′ 2″ or a total of 6′, gradually increasing going up the river to Port Royal, where the breast coal alone shows 5′ thick, the whole division being 7′, so that bearing-in is driven above the bands, leaving both brick and lower bottom benches untouched. Here the *Fishpot limestone* shows and the lower division of the *Great Limestone* above it, fully 65′ thick. Nearer Smithton the Fishpot limestone shows 20′ thick, largely superior stone, and the *Redstone coal* has been opened on J. McClellan's 2′ 9″ thick underlaid by its limestone. This coal contains much ash and is ruined by clay veins. It is 4′ thick at Smithton, and its limestone at the Waverly works is 6′ thick, furruginous but clean.

No. XV. Lisbon Basin; between the Youghiogheny river and State Line. Westmoreland and Fayette Counties.*

The trough of this basin *south* of the Youghiogheny is marked by four considerable areas of the *Upper Barren Measures*, the fourth and largest spreading over a large district in Fayette Co. and confining the Pittsburgh coal outcrop to narrow areas along the Monongahela river and the west flank of the Fayette axis.

General sections of the *Upper Productive group* and vertical sections of the Pittsburgh coal in Rostraver twp. are shown on page plate 507.

The *Waynesburg coal* is the principal source of supply in the southern end of the trough in German, Luzerne, Brownsville and Redstone twps.; to a more limited extent

* The *Lisbon basin*, south of the Youghiogheny river, lies wholly east of the Monongahela, passing south-west from Port Royal through Rostraver twp. of Westmoreland; through eastern Washington and Jefferson twps., crossing the Redstone below Parkhill's mills, and reaches Dunlap's creek 1 mile below the Menallen twp. line; Middle run a mile from its mouth, and the Monongahela river a mile higher up.

in Jefferson, whilst the same bed in Menallen and Washington is too thin to be of any economic importance.*

In Westmoreland Co. this bed is generally thin; but of good quality and 3′ thick in Rostraver and S. Huntingdon twps. Beneath it there is usually a flaggy sandstone or shale.

The *Little Waynesburg coal* shows distinctly in Fayette Co. in this basin, 2′ thick on Browns run and somewhat thicker and better on Redstone creek. The *Waynesburg limestone* is persistent throughout the Lisbon basin south of the Youghiogheny, and along Browns run becomes 35′ thick.†

The *Uniontown coal bed*, lying directly on the Great Limestone, is persistent north to the Penna. R. R. It is absent however all along Redstone creek; 20″ to 30″ thick on Dunlaps creek; perhaps 2′ 6″ on Browns run in German twp., so that it is everywhere valueless as a mining coal.

The *Great Limestone* is a marked stratum in this basin. Its upper division is readily identified as far north as the northern border of N. Huntingdon twp. in Westmoreland, varying from 6′ to 15′ in thickness all through Fayette, though apparently wanting in the vicinity of Brownsville. Its quality is very variable, sometimes a good limestone, sometimes argillaceous and a cement. The lower division attains great thickness and importance in the lower end of the trough, though thinning northward, and losing its importance along the Penna. R. R. At Brownsville 70′ thick; on the Westmoreland Co. line 55′ and on the Big Sewick-

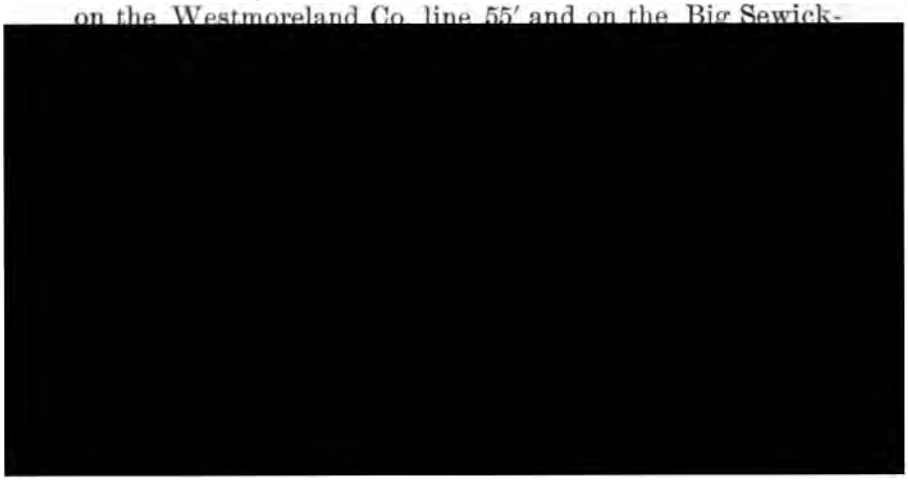
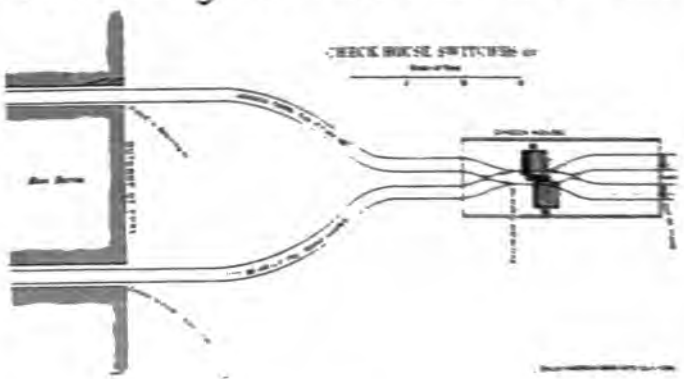
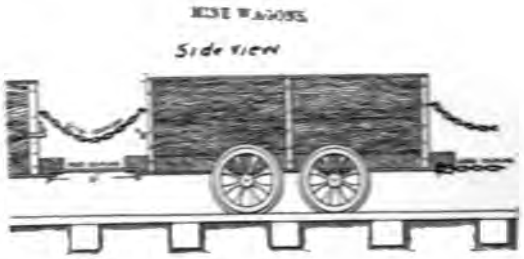
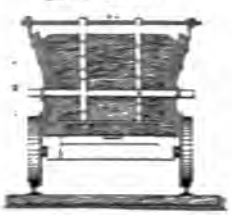


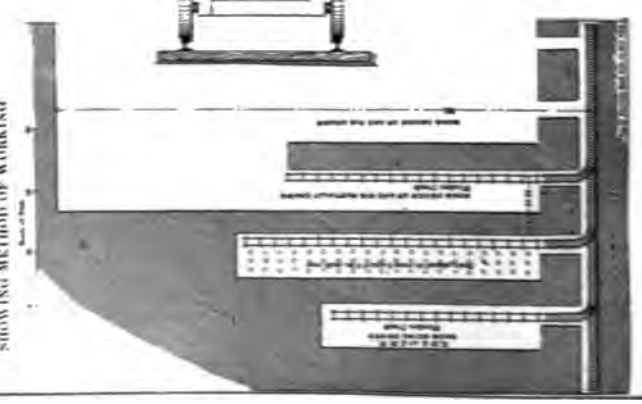
PLATE 503.

Mon XV Monongahela River Series SW Penna









creek, quite thick in Nicholson and German twps., Fayette, where it has been locally mined, but irregular northward. Absent at Brownsville; absent on Redstone creek, but workable along the river. In Nicholson 3′ to 5′; on Red stone 10″ to 2′; in Perry 3″; Rostraver 3″; Sewickley creek 2′. It carries in the south sulphur 2.432% and ash 8.165%. The *Fishpot limestone* lies close under the Sewickley coal in the south end of the trough. On Cat's run the interval is 15′ of sandy shale. On the Redstone above Brownsville 30′, containing some flaggy sandstone; on the Youghiogheny 20′ of shale.*

The *Redstone coal* is persistent as coal or shale to north of the P. R. R. On Georges creek 4′ thick, carbonaceous shale; on Redstone 1′ of coal near Brownsville and absent further up creek; in Washington twp. 2′, but in Perry on the Youghiogheny 4′, and about the same in Westmoreland Co. on the Youghiogheny and Sewickley.

The *Redstone limestone* in the same area is variable in thickness and quality.†

The Pittsburgh coal is really the only reliable member of the series. Its structure and general features *north* of the Youghiogheny have been already fully described and illustrated on plates 496 and 497. Its *average* variation between the West Virginia State Line and the Youghiogheny is as follows:

	Top Coal.	*Main clay.*	*Bottom coal.*	*Coal in upper division.*
Nicholson twp., Fayette Co., . . .	6′ 0″	0′ 10″	8′ 2″	1′0″ to 0 3″
German " " " . . .	4′ 0′	0′ 5″	8′ 3″	2 0″ to 0′ 10″
Brownsville " " " . . .	0′ 4″	0′ 6″	9′ 0″	0′ 4″
Franklin " " " . . .	3′ 0″	0′ 8″	7′ 0′	2′ 1′
Perry " " "	2′ 0′	0′ 8″	7′ 0″	2′ 0″
Rostraver " Westmoreland Co.	2′ 11′	1′ 0″	8′ 10″	2′ 0″

* Along eastern side of basin generally present to Sewickley creek; on west side it disappears before reaching the Youghiogheny. At New Salem 10′ thick and ferruginous; on the Redstone 30′ thick and of good quality; on the Youghiogheny in Fayette Co. 10′ and impure, and in S. Huntingdon 20′ of good stone.

† Absent on east side at New Geneva; present on Brown's run; wanting on Redstone and thence northward irregular and in patches. On west side

While the bed shows the usual excessive variation in its roof division and main clay parting, its lower division is everywhere of good thickness and purity. Maintaining its customary sub-divisions as a rule, it loses these characteristics in Nicholson and Springhill twps. of Fayette towards the West Virginia line, where the bed laps over the Fayette axis and partakes of the character ruling in the *Blairsville* (Connellsville) *basin*. Analyses from these districts show extremes in volatile matter of 32.815% and 34.545%; fixed carbon 59.450% and 60.241%; sulphur .895% and 1.249% and ash 4.220% to 4.655%. Its physical structure is much more variable, largely a firm bright cubical gaseous coal, but at Brownsville nearly the whole bed becomes a *block coal;* south up the river it is softer as also over the Fayette axis.

In *Rostraver twp.* of Westmoreland Co., contiguous to the gas coal district last described,* the Pittsburgh coal crops along the whole Monongahela river front, but along the Youghiogheny, except at the margin of the basin, it is deeply buried. (Sections on plate 507.)

The Waynesburg axis is responsible for the outcrop of this coal along the Monongahela river at Webster, where the bed is 300′ higher than at Port Royal, and a large amount of river coal has been mined at the *Beckett*, *Gilmore*, *Guffey*, *Webster*, *Jones* and *Iron City* mines† near Webster and Columbia (See sections on plate 507.) The bed here shows great similarity and a typical section around Webster would show a roof division of 6′ 1″; main clay

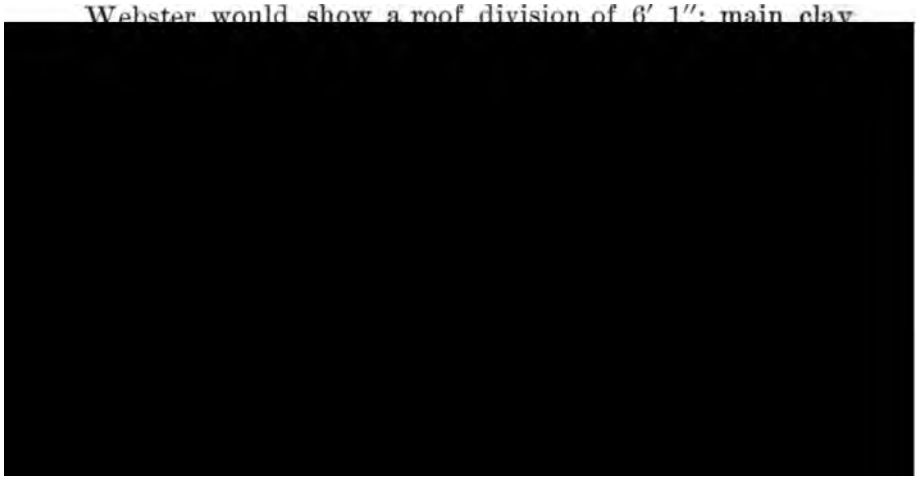


PLATE 504.

No XV Mongahela River Coal Series. Pittsburgh Coal

FORMS OF FAULTS.



COMPARATIVE SECTIONS OF PITTSBURGH COAL BED NEAR A FAULT.



THREE FORMS OF FAULTS IN BITUMINOUS COAL BEDS.

Fig. 1

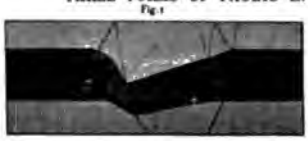


Fig. 2

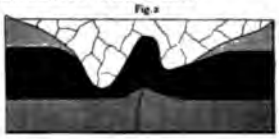
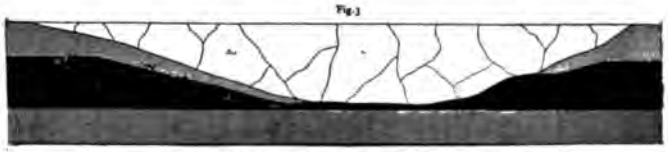


Fig. 3



FORMS OF CLAY VEINS IN BITUMINOUS COAL BEDS.

Fig. 1.

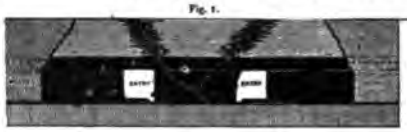


Fig. 2.

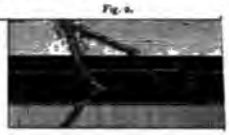


Fig. 3.



Fig. 4.



Fig. 5.



1′ 6″ and lower division 6′, with benches of 3′ 6″ to 4′ 1″, 3″, 11″ and 1′ 4″, the available thickness being about 5′.

The *Rostraver mine*, just above Lock No. 4 on the river, is 200′ high in the hills, and shows roof division 2′ 8″, main clay 0′ 2″ to 1′ 4″ and lower division 5′ 8″, with benches of 3′ 5″, 3″, 1′ 2″ and 10″. Only the breast coal is here mined, swelling in places to nearly 4′ and 20% of the output is slack and nut over 1¼″ screen. Along the Youghiogheny the character of the section changes somewhat to a roof division of 2′ 11″; main clay 1′ 0″ and a lower division of 8′ 8″, with benches of 6′ 2″, 6″, 1′ and 1′ so that the breast coal alone here will furnish 6′ of clean coal; occasionally showing a thin band of slate 1′ 3″ above bottom. The bearing-in bench is often double.

Washington twp. of Fayette Co. only shows an outcrop along the river, where the Pittsburgh coal has been worked at the *Little Pittsburgh* and *Tremont* mines near Bellevernon and the *Connecticut* and *Redstone* mines south of Fayette City (see plate 508) besides a number of smaller mines now abandoned.

The *Little Pittsburgh mine* has coked its slack coal sparingly, and was largely worked for the Bellevernon Glass Works. Its section shows roof coal 0′ 2″; main clay 10″ and lower division 6′ 5″, of which the breast coal is 5′ 0″; bearing-in 3″ and the brick and lower bottom 1′ 2″. It is claimed that the bed averages 6½′ of clean coal in the greater part of the mine. In a portion of the mine a heavy spar occurs in the roof coal where the main clay is absent, the roof lying directly on the breast coal bench.

The *Connecticut mine* shows a roof division of 3′ 9″; main clay 10″ and benches in the lower division of 4′ 10″, 3″, 1′ and 1′*; and further up a small run entering here the

*The *Stephens and Butler mine* on Little Redstone creek shows a different section (plate 508 fig. 3) with 1′ of coal in upper div.; main clay 1′ and lower div. 8′ 2″, the latter divided by 7 bands of thin slate, the upper three benches forming the breast coal 3′ 9″. The bearing-in is double, in all 5″, and the lower benches indistinct. The general average of the merchantable coal will run to 7′ 6″ along the river.

Redstone coal shows 3′ to 4′ of excellent quality 40′ above the Pittsburgh coal and *Sewickley coal* 2′ 6″.

Perry twp. holds the eastern outcrop of the Lisbon basin and shows a number of country pits along the Youghiogheny river and Washington run. The *Lynch opening* in Stickle Hollow shows a roof division of 3′ 0″; main clay 3″ and a lower division of 7′ 0″, said to give 8′ 9″, with divisions of 5′ 6″, 3″ and 3′ 0″, the latter comprising brick and lower bottom.

Near Perryopolis several openings* show a roof division of 2′ 10″; main clay 1′ 0″ and lower division 7′ 4″, the latter showing 5 benches, with breast coal 5′ 9″, bearing-in 4″; brick 5″ and lower bottom 7″. The whole lower division yields a good coal; but 1′ 8″ are left to support the roof and contains more slate and sulphur than the lower benches†.

Jefferson, *Brownsville* and a part of *Franklin* enclose all the Pittsburgh coal bed area from the river to the Fayette axis north of Redstone creek. There are numerous mines along the Monongahela river as the outcrop is above water level, except in a sub-basin a mile below Redstone creek, and extends up the latter about a mile‡.

At *W. M. Lyon's mine* on Redstone creek the roof division 5′, shows no coal at all and the lower division 8′, shows no distinct partings (plate 508 fig. 7). The quality of the coal is the same as around Brownsville, where the lower

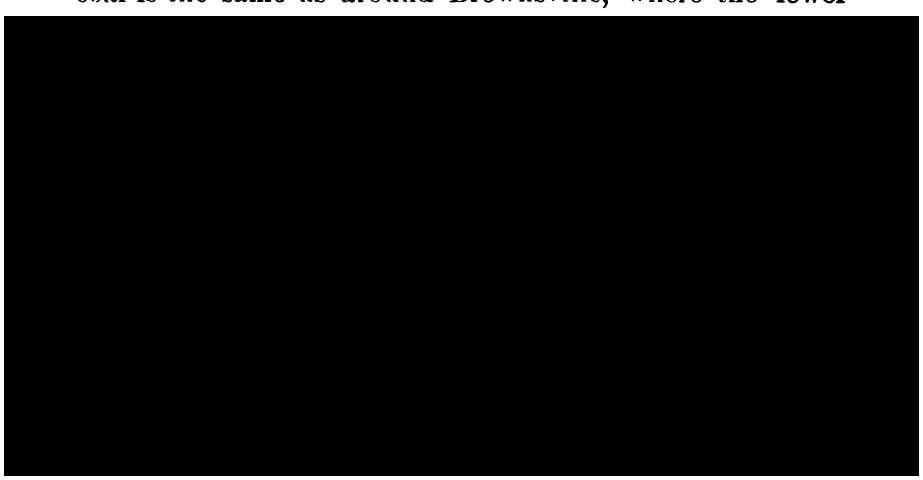


PLATE 505.

XV. Pittsburgh bed. Westmoreland Co.

WIRE ROPE HAULAGE
AT
LARIMER COLLIERY

division is the same whilst the roof division contains 8″ of coal.

Along Dunlap's creek a complete section of the *Upper Productive measures* shows (see plate 494 fig. 3). *Wood's bank* here shows a roof division 8″; main clay 10″ and lower division 7′ 6″, divided by very thin but distinct partings into benches of 4′ 5″, 5″, 4″ and 2′ 4″, of which the two central form a double bearing-in, which seems to be a common feature in the southern end of the Lisbon trough.

Along the river the many openings show the roof division to consist wholly of coal 1″ to 5″; main clay 4″ to 10″ and the lower division 7′ 6″ to 9′, the variations being caused by swelling in the under clay. The upper 2′ of the breast coal contains numerous thin binders; but the whole bed is merchantable coal, free burning, sometimes block. Clay veins are numerous. Some little coke has been made from the slack coal here.

Along the river there are at least a dozen openings,* all furnishing coal to the *Fourth Pool* shipments, the Lisbon basin being sub-divided by a small axis into two separate divisions. The data obtained at these mines in 1886 can be best shown in tabular form:—

	Roof Division.	*Main Clay.*	*Lower Division.*			
			Breast.	*Bearing-in.*	*Brick and Low. Bottom.*	
Hall mine,	0′ 8″	0′ 10″	5′ 5″–6′ 0″	3″–4″	2′ 4″	
Troytown,			5′ 0″	0′ 3″	2′ 6″	
Bargeddie,			5′ 4″	0′ 2″	2′ 4″	
Snow Hill,			5′ 3″	0′ 3″	2′ 6″	
Little Alps,	4″–6″	1′–1′ 2″	4′ 0″–5′ 0″		2′ 0″	
Cedar Hill,	0′ 4″	1′ 0″	5′ 0″	0′ 3″	1′ 2″	1′ 6″
Climax,			6′ 0″	0′ 3″	1′ 2″	1′ 3″
Albany,	1′–1′ 3″	1′ 0″	3′ 3″	0′ 3″	3′ 0″	

The general practice is to leave in the lower bottom coal, rarely distinct from the brick, the breast coal yielding all the way from 3′ 3″ to 6′ 0″, averaging about 5′ 6″. When thin, a portion of the bottom coal is also raised. In the *Hall mine* there are several swamps rendering the coal

*Beginning at the Washington line these are the Hall, Troytown, Bargeddie, Snow Hill, Merchant, Little Alps, Cedar Hill, Stony Hill, Climax, Albany and Dean mines, largely figured on plate 526.

irregular, thicker usually in these swamps than on the corresponding rolls. The bottom 2′ 4″ is not mined here nor in the Troytown mine, where the breast coal yields 5′ 0″.

In the *Bargeddie mine* only 9″ is left in the bottom, and at Snow Hill, the entire bed averages 8′, of which 2′ 6″ below the bearing-in is not mined.

In the *Little Alps mine* the yield is entirely from the breast coal 4′ to 5′; but at *Cedar Hill* and *Stony Hill* all but 6″ of bottom coal is mined, yielding 7′ 5″. The *Climax mine* takes out only the breast 6′ thick, giving about 67% lump and 33% nut and slack. At *Dean's pit* on Redstone creek the bed reaches nearly 9′, of which about 6′ is mined. The Upper Productive Measures are frequently well exposed through this area.*

In *Franklin* only a limited outspread of these measures occurs along Crabapple run. The *Hazen and Burton mine* shows the character of the Pittsburgh coal along the eastern outcrop to be: roof coal 2′ 11″; main clay 0′ 8″ and lower division, not all seen, 7′, with partings indistinct. Ogelvies and Piersol's pits show about 6½′ of merchantable coal.

Redstone, *Luzerne* and *Menallen twps.* comprise another block of the Upper Productive Measures, between the Monongahela and the Fayette axis south of Redstone creek, and extending to the latitude of Coal run and New Salem. Along the river the Pittsburgh coal is exposed for a short distance above Brownsville, but is generally under water



PLATE 506.

XV. Pittsburgh bed. Westmoreland Co.

Plan of Top of Tipple Showing Scales Connection.

Larimer Tipple

OF THE

WESTMORELAND COAL COMPANY

By A.N. Humphreys.
Engineer Westmoreland Coal Co

SCALE ⅛ INCH TO ONE FOOT.

axis lifts the coal to higher elevations on the west bank of the river, where it is largely mined; but the *Evans pit* is the only opening on the Fayette side, showing 10′ thick, of which 8′ represents the lower division. At Lock No. 5 this coal is not over 15′ below the dam, and in the trough of the basin above Lock No. 6 it is 100′ beneath the river. *Jacobs Slope* below Coal run, 389′ long, reaches the coal at 112′ below low water mark, where the bed is 11′ thick. The Waynesburg coal 350′ higher, is within easy reach all along the river hills, usually a worthless mass of coal and slate, with a bottom 3′ bench. Along Redstone creek the *Pittsburgh coal* is nearly at water level between Redstone and Menallen twps., but above the creek for some distance towards Cook's mills, and the *Waynesburg coal** shows south of Parkhill's mills 4′ 3″, in 8 bands of shale and coal, the bottom thick benches, 1′ 8″ and 2′ 5″, being ashy.

The *Pittsburgh coal* is mainly opened in Menallen twp. on the eastern rim of the basin in a series of country pits rising up to the Fayette axis. The *Boyd mine* works the entire lower division 5′ 10″ thick. The *Roderick pit* shows the breast coal 7′ thick; bearing-in 3″ and the two bottom members over 1′ thick. At *Woods pit* the bed swells to 11′, of which 9′ is taken out; 6′ 6″ above the bands.

German, Nicholson and a part of *Spring Hill* form a narrow wedge-shaped area in Fayette holding the eastern half of the Lisbon basin. Along the river the Pittshurgh coal first appears below Cat's run† and is well displayed along that stream owing to the hoist of the Fayette axis. Numberless small pits penetrate its outcrop here and along the eastern margin of the basin, which is rapidly spooning out towards the State line.

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*Along Dunlap's creek this coal is 6′ to 7′ 2″ thick; but it still yields inferior coal from its two main benches 1′ 6″ and 2′ 2″, separated by clay 10″ to 2′ thick.

†On Cat's run Sewickley coal shows on *Poundstone's property* 5′ thick and 98′ above Pittsburgh coal, the latter showing at Masontown 13′ 3″ thick, with a roof div. 5′ 5″; main clay 10″ and lower div. 7′ thick. On Brown's run to the north, the *Kendall mine* shows this bed 12′ 7″, with roof div. 3′ 4″; main clay 1″ to 5′ and lower div. 9′ 1′. On both runs the upper divi-

In *Nicholson*, around New Geneva, the *Pittsburgh coal** is 300′ above the river, and in numerous openings the roof shows an irregular mass of coal and clay 3′ to 4′ thick, while the lower division averages 8′ 6″, in some places 9′ thick, of excellent quality and in appearance and character quite similar to that found in the Connellsville basin.†

No. XV in Allegheny, Washington and Greene Counties.

These three counties, with limited portions of Westmoreland and Fayette tributary to the Monongahela river, form the "*Pittsburgh District*," a name commercially applied to that area of the Pittsburgh coal in south-western Pennylvania outside the *Connellsville* (Blairsville) and main *Irwin* (Lisbon) *basins*, whose coal partakes more generally

sion is worthless and divided by slate bands; but the lower division is good and has lost its partings to a great extent.

On Dunlaps creek the lower division is about 8′ thick, while to the south towards Nicholson, in the Coffman, Sopper and Poundstone pits the roof div. is 3′ 10″; main clay 1′ and lower div. 7′, the top 8″ of lower div. being slaty.

*Below the coal, and separated from it by 4′ of clay is a bed of gray carbonate iron ore, formerly much worked, and occupying the position of the *Oliphant Blue Lump* further east. This deposit is very persistent along the river face from New Geneva to below the mouth of Cat's run, the northern boundary of the township, where the coal goes under the river. On Georges creek it is finely exposed on Judge Crow's property, where it is very compact, 2′ to 3′ thick, and evidently a very good ore. The quantity

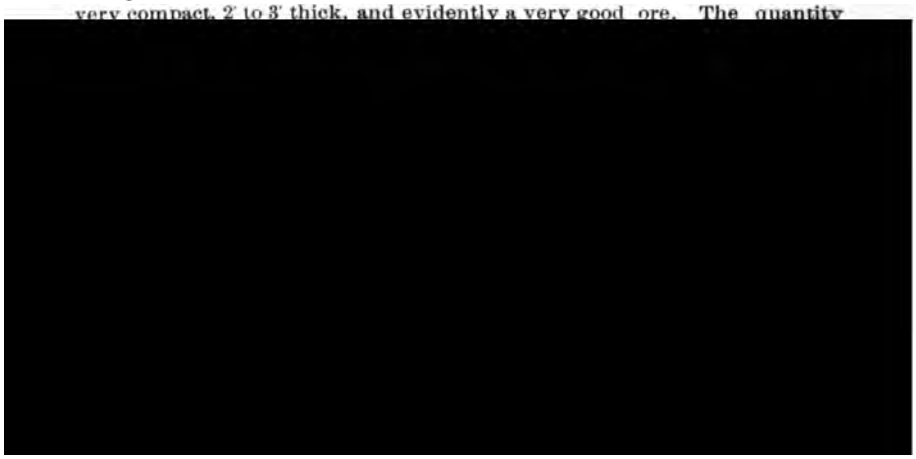
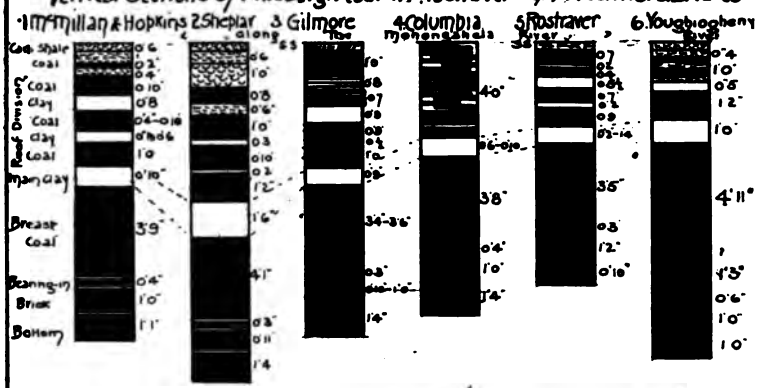


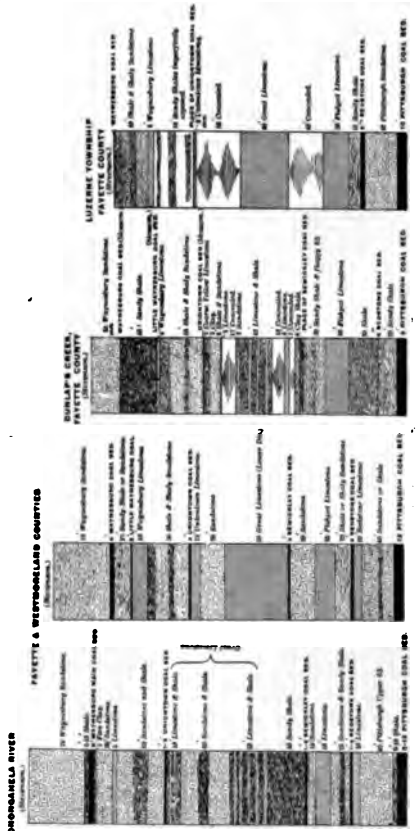
PLATE 507.

No XV. Monongahela River Series Westmoreland and Fayette Counties

Vertical Sections of Pittsburgh Coal in Rostraver Twp. Westmoreland Co



GENERALISED SECTIONS OF THE UPPER PRODUCTIVE COAL MEASURES IN FAYETTE AND WESTMORELAND COUNTIES.



of a character suitable for domestic and steam purposes than for the manufacture of coke and gas.*

Allegheny Co. may be conveniently divided, so far as area of the *Monongahela River Series* are concerned, into three parts, *1st.*: That portion lying north of the Ohio and Allegheny rivers, containing only about a dozen small remnants of the Pittsburgh coal; *2nd*: That portion lying between the Allegheny and Monongahela rivers, containing some larger patches of this coal, mainly in the *Leechburg synclinal*, and whose coal is largely exhausted and *3rd.* A southern belt, south of the Monongahela river, embracing a much more compact and larger area of the Pittsburgh coal.

The structure of this district will be best understood by reference to plate 513 also showing the peculiarities of the area in the neck between the Monongahela and Youghiogheny rivers.†

*Like other fields just described, it is impossible to draw any fixed geographic limits to this district, for the typical gas coals of Westmoreland continue geologically across Youghiogheny river, both southward into Fayette Co. (as described) and westward to Monongahela in Allegheny and Washington. While therefor there is only a gradual change in character and structure of bed, approaching the Monongahela river from the north-east, as well as a more marked change in ascending that river from Pittsburgh, it is not possible to exactly limit application of the terms "*coking coal*" and "*gas coal*" to fixed areas; but in as much as the Pittsburgh coal and the Upper Productive Measures have been already described in the various basins within Westmoreland and Fayette Cos., it only remains to briefly summarize the general features in the other three counties, already minutely described in Reports K and KK by Dr. J. J. Stevenson in 1875-76; by E. V. d'Invilliers in the Annual Reports for 1885 and 1886, and by J. Sutton Wall in Report K4.

†Recent careful instrumental surveys along Allegheny river by Mr. Selwyn Taylor of Pittsburgh, between Pucketa creek and city limits, have demonstrated the presence of a new anticlinal or rather the propriety of shifting the *Baydad—Pin Hook axis* (at least south of Pucketa creek) considerably further west. Mr. Taylor notes presence of a well marked axis crossing Bull run west of Tarentum and passing south-west through bend of river at Verona and again cutting river near corner of Penn twp., expiring south-west near Coleman area of Pittsburgh coal. This axis slopes south-west 33′ per mile, whilst the basin to the east (almost directly in line with the Pin Hook anticlinal south of the Monongahela) slopes in same direction only 18½′ per mile. He therefor removes the Pin Hook axis south of Pucketa creek altogether, as he finds the coal measures rising uniformly north-west from his *Leechburg basin* line to the new *Tarentum—Verona axis*, as shown in plate 513.

Owing to the oft-repeated description of the structure of the region (the general rise of the measures in a north-east direction) the outcrop of the *Pittsburgh coal* in Allegheny is far greater than in Washington and Greene Cos., thereby assisting development and rendering the extraction of coal much more economical and rapid. Moreover since a very large proportion of this coal seeks a market to the south and south-west through the Monongahela river, it has certain advantages in tolls, besides bearing transportation better than the softer coal of the Upper Monongahela, nearer the State Line.

The enormous tonnage annually sent to market through the locks of the *Monongahela Navigation Co.*, nearly all of which is consumed without the state, and representing shipments of lump and nut coal only, can be best shown in the following table:—

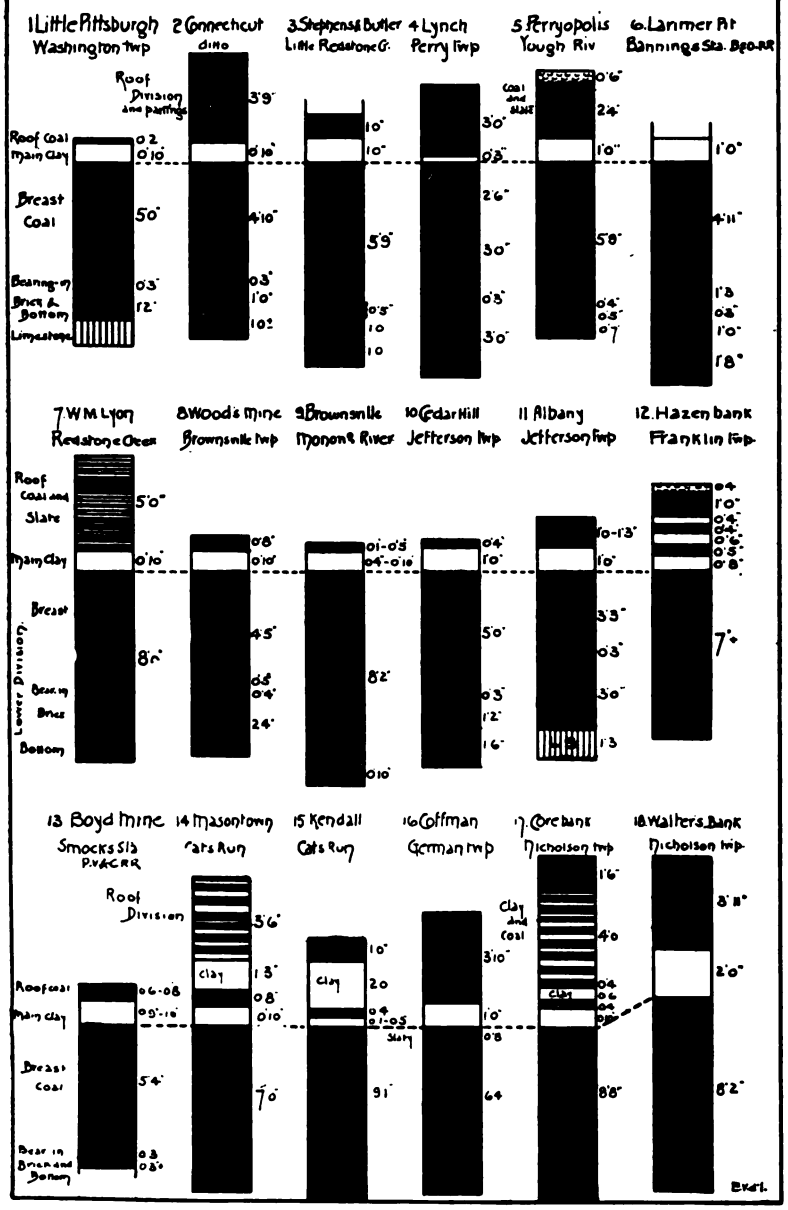
Shipments of coal through the Monongahela Navigation Company's locks, since November 11, 1844.

YEAR.	POOLS.					Total in bushels.
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	
1844, ...	737,150	. . . . .	. . . . .	. . . . .	. . . . .	737,150
1845, ...	2,527,879	1,328,604	314,342	434,360	. . . . .	4,605,185
1846, ...	3,167,528	3,091,639	767,708	752,036	. . . . .	7,778,911
1847, ...	3,377,703	4,188,258	1,227,201	851,965	. . . . .	9,645,127
1848, ...	3,536,761	3,986,643	1,436,666	859,291	. . . . .	9,819,361
1849, ...	2,944,044	4,420,347	1,434,723	909,393	. . . . .	9,708,507
1850, ...	3,988,200	5,540,470	1,862,548	906,749	. . . . .	12,297,967
1851, ...	4,105,624	5,846,168	1,769,302	800,134	. . . . .	12,521,228
1852, ...	4,797,704	7,188,539	1,736,622	907,976	. . . . .	14,630,841
1853, ...	5,372,732	7,325,062	2,015,250	1,003,323	. . . . .	15,716,367

[redacted]

PLATE 508.

No XV Monongahela River Series in Fayette County
Vertical Sections of the Pittsburgh Coal in Waynesburg Basin.



Shipments of coal through the Monongahela Navigation Company's locks, since November 11, 1844—Continued.

YEAR.	POOLS.					Total in bushels.
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	
1880.	10,319,100	40,443,450	15,306,300	17,979,500	. . . . .	84,048,350
1881.	8,713,260	47,344,500	14,148,800	15,448,100	. . . . .	86,254,660
1882.	11,343,700	49,888,700	18,606,700	21,595,600	. . . . .	101,434,700
1883.	11,624,500	58,208,300	18,151,400	20,503,600	. . . . .	108,487,800
1884.	10,482,100	31,218,000	17,619,200	19,920,800	29,000	79,269,100
1885.	11,462,450	34,219,200	15,677,300	21,085,100	15 000	82,459,050
1886.	15,926,600	49,188,000	20,459,847	24,315,700	5,000	109,895,147
1887.	9,581,000	29,799,500	16,938,900	20,312,500	. . . . .	76,631,900
1888.	15,109,400	43,971,000	23,876,500	29 504,000	. . . .	112,460,900
1889.	8,473,100	26,902,500	16,910,200	27,282,700	. . . . .	79,568,500
1890.	13,935,800	39,202,000	22,563,500	40,601,300	. . . . .	116,302,600
1891.	13,318,700	32,547,000	21,702,900	39,346,100	. . . . .	106,914,700
1892.	11,183,000	23,824,350	15,856,600	45,913,600	40,800	96,818,350
1893.	5,883,200	22,574,500	18,977,100	48,899,900	167,100	96,501,800
1894.	11,677,913	25,086,000	20,735,500	58,457,000	283,900	116,240,313
Totals in bushels,	408,475,727	1,164,129,313	464,832,795	602,403,386	833,300	2,640,674,521
Totals in tons, * .	15,531,396	44,263,472	17,674,251	22,905,072	31,684	100,405,874

* Estimating 1 ton equal to 26.3 bushels.

Allowing an average of 100,000 bushels of coal to the acre, these totals represent a depletion of 26,406 acres, tributary to the Monongahela Navigation Co's. slack-water system, not estimating the large additional tonnage of mines shipping solely by railroad, or the product of many contiguous country pits. The aggregate of 100 million tons represents the river shipments of the past 50 years.

In *Allegheny Co.*, the Upper Productive Measures, other than the Pittsburgh coal, have practically no significance.*

This coal is everywhere good; everywhere workable; and while its mining section has decreased (and its worthless roof member increased) as compared with its section in the upper river district, it is always of commercial size and character, though suffering an infinite number of changes in "swamps" and "rolls," due to irregularity in its roof and floor.

In *Northern Allegheny* perhaps 250 acres of the Pittsburgh coal remain to attest the former much greater outspread of this bed and the enormous erosion it has suffered.

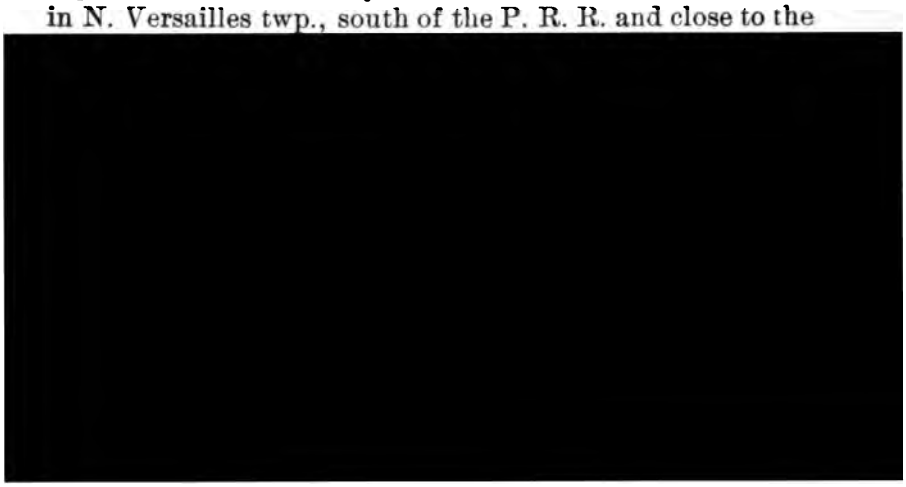
*The *Waynesburg coal* is virtually unknown; the *Uniontown* and *Sewickley coals* scarcely extend as far north as southern Allegheny, and while the *Redstone coal* is much more persistent and widespread and can be found at many places south of the Monongahela river, it rarely is of a character or thickness to justify working and is nowhere mined on a commercial scale.

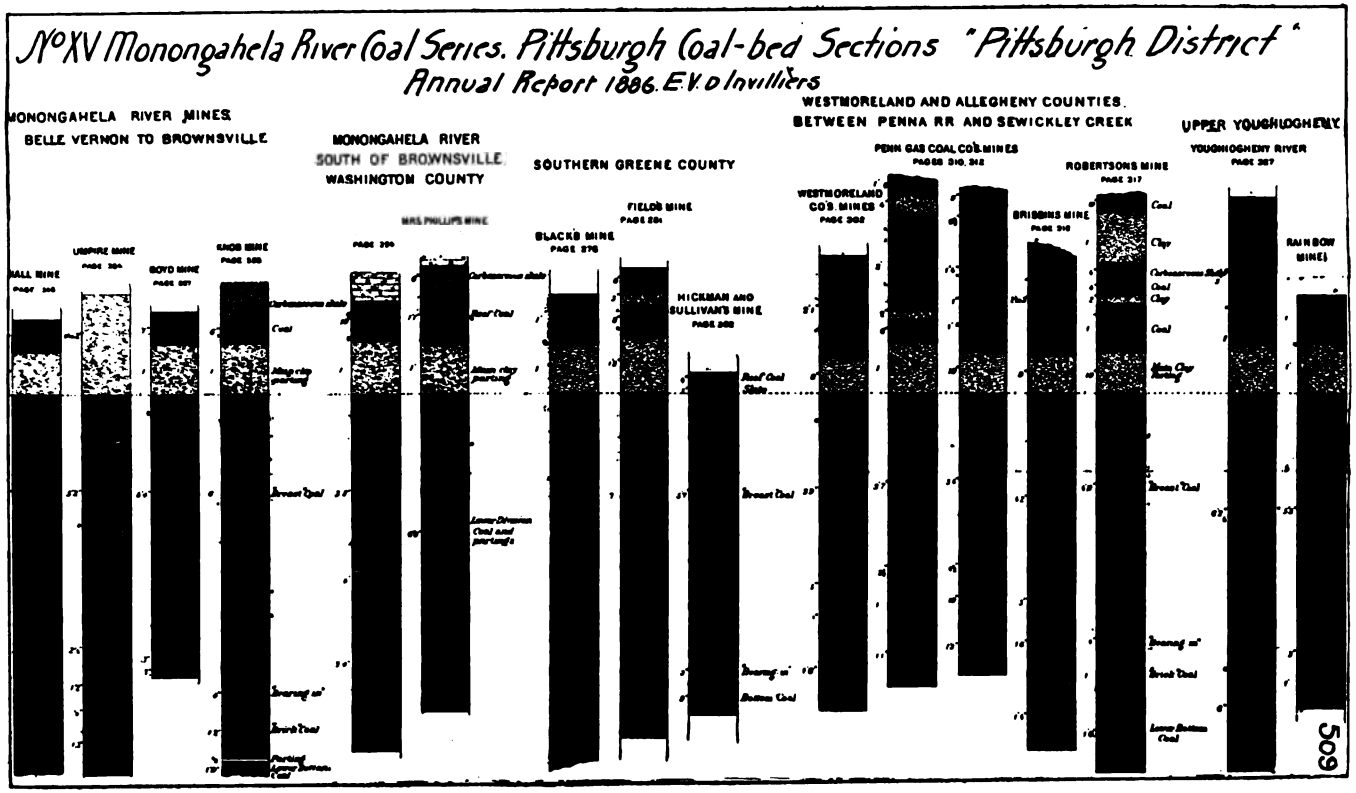
The *Wright bank* in Franklin twp.* (plate 512) shows a section quite similar to many of the river mines, a roof division of 6′ 6′ (divided in center by 1′ 6″ of shale); a main clay parting 1′ 2″ and lower division 4′ 10″, of which 2′ 9″ is breast coal ; 5″ bearing-in and partings and 1′ 8″ brick and bottom. There is only 30′ of cover and the coal is not good.

Eastern Allegheny Co. has a somewhat greater area of the Pittsburgh coal, and though the geological maps will show the irregular and patchy distribution of the bed, an enormous tonnage of most excellent gas and steam coal has been taken from these areas, the mines being extensive and the entries bridging over barren ravines into successive areas of the coal.

All the coal north of the Penna. R. R. dips from the Allegheny river towards *Thompson's run* and the *Leechburg basin*, the coal pitching south-west in the basin 18½′ per mile while along the anticlinal on the Allegheny it slopes much more rapidly in the same direction, 33′ per mile.

The principal mines† in this area are those of the *New York and Cleveland Gas Coal Co.*, at Center, Plum creek and Sandy creek ; the *Hampton and Duquesne mines* at Wilkinsburg; the *Oak Hill collieries* along Thompson run, and the *Springhill mines* along Turtle creek. In all these mines the roof division is worthless and variable. A good type of this division may be seen at the *Rush White pit* in N. Versailles twp., south of the P. R. R. and close to the




No XV Monongahela River Coal Series. Pittsburgh Coal-bed Sections "Pittsburgh District"
Annual Report 1886. E.V. d'Invilliers
MONONGAHELA RIVER MINES
BELLE VERNON TO BROWNSVILLE
MONONGAHELA RIVER
SOUTH OF BROWNSVILLE
WASHINGTON COUNTY
SOUTHERN GREENE COUNTY
WESTMORELAND AND ALLEGHENY COUNTIES.
BETWEEN PENNA RR AND SEWICKLEY CREEK
UPPER YOUGHIOGHENY
YOUGHIOGHENY RIVER
HALL MINE
UMPIRE MINE
BOYD MINE
KNOB MINE
MRS. PHILLIPS MINE
BLACKS MINE
FIELDS MINE
HICKMAN AND SULLIVAN'S MINE
WESTMORELAND CO'S. MINES
PENN GAS COAL CO'S MINES
BRISBINS MINE
ROBERTSONS MINE
RAINBOW MINES
Coal
Clay
Limestone
Fire Clay
Roof Coal
Slate
Pittsburg Coal
Drawing at
Bottom Coal
Lower Bottom Coal
509

split up by 5 partings into 6 benches of coal, respectively 6″, 1½″, 1″, 3½″, 1′ 1″ and 10″ thick, the slates being from ½″ to 7″ thick. The main clay parting in this district, while varying also, will average 1′ thick. The lower division everywhere shows its characteristic separation into breast, bearing-in, brick and bottom benches, with extremes respectively of 3′ 2″ to 3′ 10″; 3″ to 7″; 4″ to 1′ 0″ and 10″ to 1′ 9″, this latter or lower bottom coal rarely being mined. The merchantable coal will closely approximate 4′. Within the city limits of Pittsburgh the coal lies in isolated patches over 1000′ above tide.

The *Washington anticlinal* enters from Scott twp. on the south, closely following the Washington pike, and lifting the Pittsburgh bed by reason of its north-east rise, to an elevation of about 1030′ A. T. along the river bluff.* This axis is likewise indistinct north of the river, unless as is probable, it coalesces with the newly defined axis† first noticeable north of East Liberty at the *Coleman pit*, and extending along the river west of Verona and Tarentum, rising 33′ per mile.

In *Penn twp.* a large country trade has been done and is still being carried on to satisfy local wants at East Liberty and Wilkinsburg, at *Masons*, *Elks*, *Lytles* and other pits along the Frankstown road. In all the roof coal is from 3′ to 3′ 6″ thick; the main clay parting 9″ to 1′ and the lower division 5′ 4″ to 5′ 11″. The mining coal shows about 3′ 2″ of breast, and about 4″ of brick which, with the bearing-in, makes in all 3′ 10″. The lower bottom is dirty; and the whole bed quite irregular. (Plate 512.)

In the *Sandy Creek mines*, which have furnished a large

---

*Its exact location cannot be well made out, for its strength as a distinct axis is visibly decreasing as the river is approached, with the effect of creating a broad plateau of the Upper Productive and Barren Measures, deeply furrowed by Saw Mill run and its numerous branches. As a consequence, the Pittsburgh coal from Temperanceville on the west to the eastern limits of the city beyond the Jones and Laughlin mines nowhere varies 20′ in elevation along the river bluff.

†This was described in the Annual Report for 1886 as the *Pin Hook axis*, which, as was then intimated, must now be shifted further west along the Allegheny river.

amount of high grade gas coal, the coal approximates 1080′ A. T. and shows about 3′ of breast; 6″ to 8″ bearing-in; 10″ to 1′ of brick and 1′ to 1′ 6″ bottom coal. (Plate 512.)

M. Graver & Co's. mine enters the western outcrop at 1135′ A. T., their coal road extending by a series of tunnels and trestles to Armstrong sta. on the A. V. R. R., and shows about the same conditions, averaging about 5½′ of mining coal here as well as in the *Plum Creek Mine No. 1* of the N. Y. & C. Gas Coal Co. There is however a noticeable difference in the character of the coal at these two places, the Sandy creek product being essentially a gas coal while the Plum creek output has a much lower percentage of volatile matter and is a stronger steam coal.

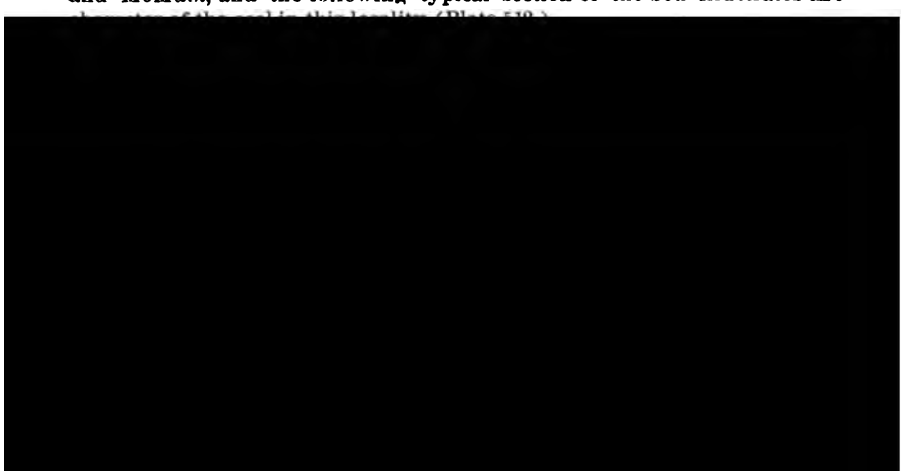
Plum twp. is largely devoid of merchantable coal except in the southern portion along Plum creek, where are located the *Centre mines* of the New York and Cleveland Co.*

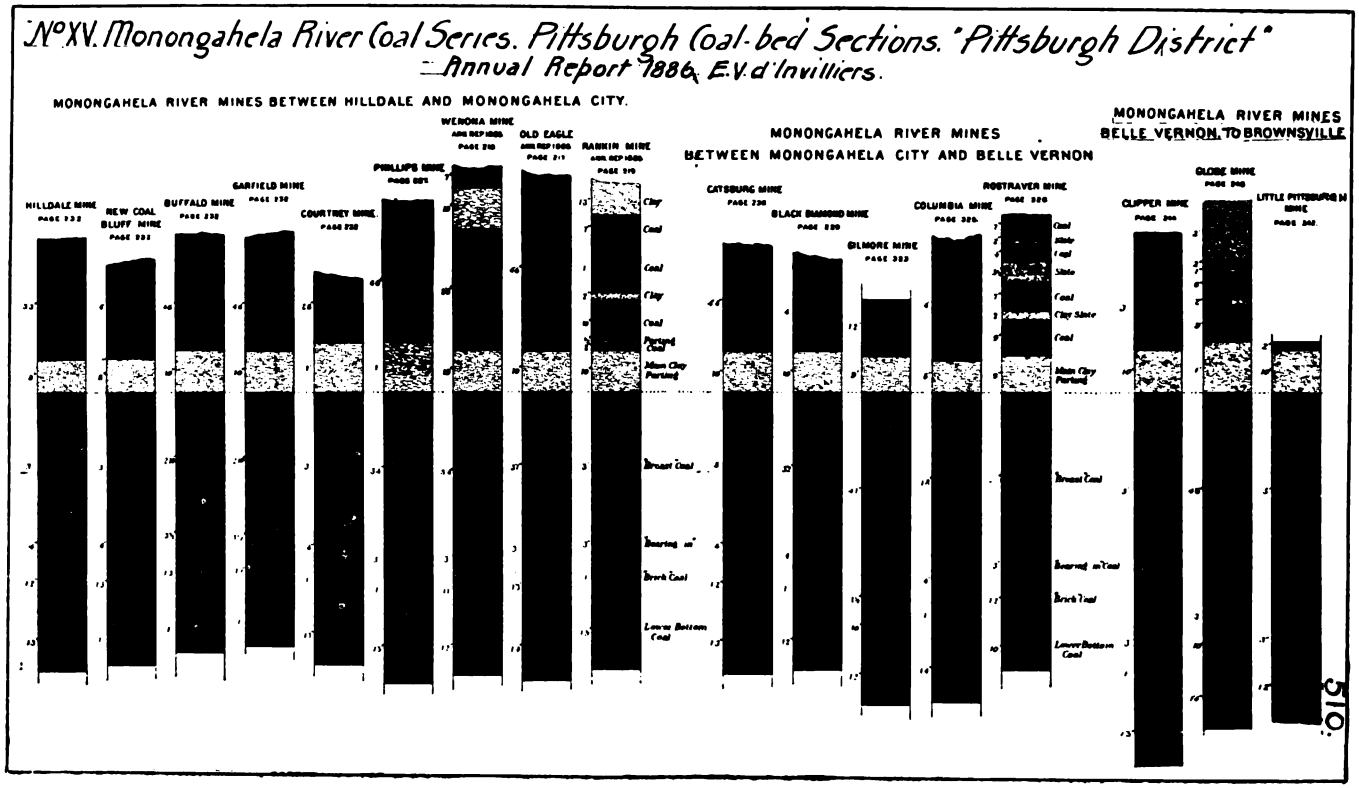
Oak Hill mine No. 4 has furnished a large amount of coal, on the east side of creek in Patton twp., the roof division being 2′ 2′; and lower division 6′ 10″, with benches

*North-east of New Texas there are half a dozen small patches left between small branches of Plum creek, each of which is insignificant in size, though containing a coal pit worked for the local supply of the community.

A somewhat larger area is held between branches of Armstrong run east of McMath's school house, and a couple of outlying patches are still left in the bluffs overlooking Pucketa creek to the north.

In the larger area the coal has been mined by *Messrs. Armstrong, Logan* and *McMath*, and the following typical section of the bed illustrates the




No XV. Monongahela River Coal Series. Pittsburgh Coal-bed Sections. "Pittsburgh District"
Annual Report 1886, E.V. d'Invilliers.
MONONGAHELA RIVER MINES BETWEEN HILLDALE AND MONONGAHELA CITY.
MONONGAHELA RIVER MINES BETWEEN MONONGAHELA CITY AND BELLE VERNON
MONONGAHELA RIVER MINES BELLE VERNON TO BROWNSVILLE
HILLDALE MINE
NEW COAL BLUFF MINE
BUFFALO MINE
GARFIELD MINE
COURTNEY MINE
PHILLIPS MINE
WENONA MINE
OLD EAGLE
RANKIN MINE
CATSBURG MINE
BLACK DIAMOND MINE
GILMORE MINE
COLUMBIA MINE
ROSTRAVER MINE
CLIPPER MINE
GLOBE MINE
LITTLE PITTSBURGH MINE
Clay
Coal
Coal
Clay
Coal
Pittsburgh Coal
Main Clay Pursong
Breast Coal
Bearing in Coal
Brush Coal
Lower Bottom Coal
510

of 3′ 10″, 6″, 9″ and 1′ 9″, the breast coal bench carrying a thin slate 2′ 7″ from top (see plate 512.)

The *Duquesne* and *Hampton works* in Wilkins twp. are pretty well exhausted as also *Oak Hill No. 3* along Thompson's run, the lower division showing benches of 3′ 2″, 4″, 1′ 0″ and 1′ 2″ as in the *Curry pit* (see plate 512.)

In North and South Versailles twps., occupying the corner south of the P. R. R. and between Westmoreland Co. and the river, the Pittsburgh coal is well exposed on the western flank of the Roaring Run axis in the first township, and in a few isolated patches in South Versailles.*

The *Keystone mine* shows the coal 225′ above the P. & L. E. R. R., extending a mile back to Crooked run where it meets one of the *Spring Hill mine* entries coming south from the Penna. R. R. The coal is largely worked out, the lower division showing benches of 3′ 9″, 3″, 10″ and 1′, though of course subject to local variations. The breast coal will average about 3′ 6″ in addition to which about 1′ of the bearing-in and brick coal is won, or say 4′ 6″ in all.

Lincoln, Elizabeth and Forward twps.† are specially illustrated in page plate 513 which shows the outcrop of the Pittsburgh coal along both rivers and the sub-divisions of the western wing of the *Lisbon basin*, west of the Waynesburg axis. In this area the coal is mined extensively for both river and railroad shipments. The pre-

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† Throughout all this portion of the field the coal is quite irregular. Horsebacks, soot-veins and kindred troubles rarely occur, though clay veins, running in every direction, from 3″ to 6″ wide, are frequently met with. Swamps are reported in the *Keystone works* and also appear across the line in the *Larimer mines* of the Westmoreland Coal Co. The principal trouble arises from swellings from the main clay parting, causing sudden variations in the size of the coal. Near the clay veins, too, the coal is found twisted in places for a considerable distance.

The amount of cover of the *Upper Productive Measures* is generally light. The highest rock exposed is a portion of the Great Limestone, seen along the Greensburg pike south-west of the old toll house. It is thin however and imperfectly exposed, though yielding a fair quality of lime. Neither the *Redstone* or *Sewickley coals* could be located, though their horizon was reached at several places.

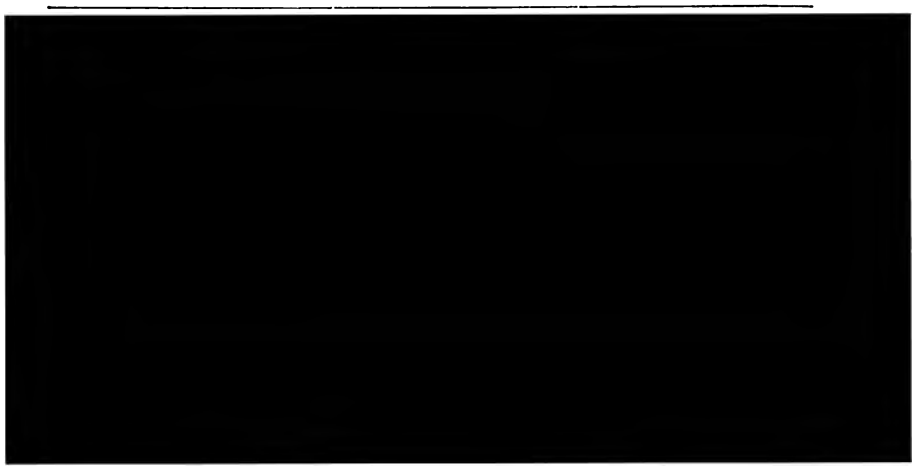
† See Annual Report 1885. E. V. d'Invilliers.

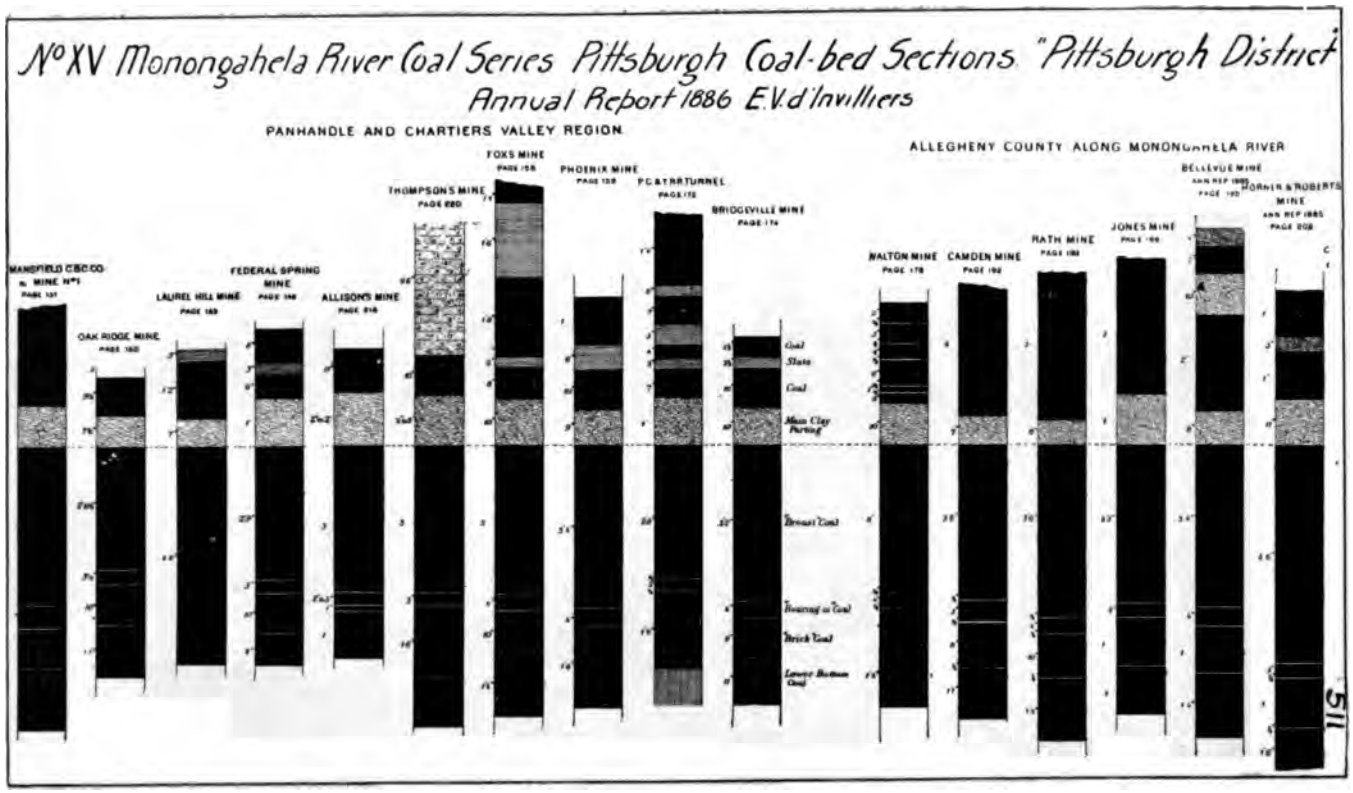
dominating structural feature of the district is the *Murraysville axis.**

The Pittsburgh coal along the Monongahela river is largely tributary to river shipments in *Pools Nos. 2 and 3*, and sections of the bed are shown on the three page plates 523, 524 and 525 and the *Youghiogheny mines* in plate 522. The entire product of the Pittsburgh coal bed south of the Youghiogheny and west of the Waynesburg axis is at present shipped for gas or steam purposes.†

Over the arch of the Murraysville axis in Lincoln twp. the Pittsburgh coal is entirely eroded, though it occurs close by at over 1100′ A. T. From this axis line north-west everything dips towards McKeesport at the rate of about 75′ per mile. From the Pittsburgh coal on the summit to the Monongahela river, there are over 250′ of *Barren Measures* exposed. The most noticeable feature of this section is the outcrop of the *Morgantown sandstone* 20′ to 30′ thick, which here rises well up from the river, and presents a bold escarpment.

Robbins and Jenkin's mine (plate 523 fig. 50) shows a typical section of the coal bed. The breast coal is from 3′ to 3′ 4″ thick, with 4″ bearing-in coal, and 1′ of brick coal, with the usual small slate partings between these members. The bottom coal 1′ 6″ thick, is not mined, and the main clay varies greatly from 6″ to 14″. In some parts of the mine this clay is a mere knife edge between the breast and




No XV Monongahela River Coal Series Pittsburgh Coal-bed Sections "Pittsburgh District"
Annual Report 1886 E.V.d'Invilliers
PANHANDLE AND CHARTIERS VALLEY REGION
ALLEGHENY COUNTY ALONG MONONGAHELA RIVER
MANSFIELD C&C CO. & MINE No 1
OAK RIDGE MINE
LAUREL HILL MINE
FEDERAL SPRING MINE
ALLISON'S MINE
THOMPSON'S MINE
FOXS MINE
PHOENIX MINE
P.C.&T.R.R. TUNNEL
BRIDGEVILLE MINE
WALTON MINE
CAMDEN MINE
RATH MINE
JONES MINE
BELLEVUE MINE
MORRIS & ROBERTS MINE
Coal
Slate
Coal
Main Clay Parting
Pittsburgh Coal
Freeport Coal
Brush Coal
Lower Bakewell Coal
511

roof members. The latter are about 3′ thick, though no coal over 5″ is found in them.

The *Penny mine* (plate 522 fig. 73) on the Youghiogheny shows a similar section in main tunnel and is connected with the Robbins and Jenkins. The roof division however is 4′ thick, with a bottom coal and slate 2′ separated by 1′ of clay from the upper coal 1′ 1″, also slaty.

The *Productive Measures*, above the Pittsburgh coal, north of the axis, are exposed up to the Great Limestone, 160′ above the coal. The lower division of this limestone is quarried and burned on the summit east of the Pleasant Valley school-house in the Edmunson quarry. The stone is reported as making an excellent lime. The *Redstone coal* is worthless and slaty here, and is 60′ above the Pittsburgh, and the *Sewickely coal* horizon was not noticed.

On the south side of the anticlinal there is an area underlaid by the *Upper Productive Measures* nearly equal to that on the north side of the axis. The *Bellevue mine* opening on the river, mining back to Wileys's Hollow, (see plate 523 fig. 49) further emphasizes the persistent character of the Pittsburgh coal, its roof division and partings being 3′ 9″; main clay 0′ 8″ and lower division 6′ 0″, with benches of 3′ 4″, 4″, 1′ 0″ and 1′ 4″, furnishing about 4½′ of commercial coal.

In *Elizabeth twp.* there is a much greater outspread of the Pittsburgh coal, its constant south-east dip bringing it much lower in the hills and confining its outcrop to the two river banks, where it shows 150′ higher on the Monongahela river side than on the Youghiogheny. The rocks exposed extend from 275′ above the Pittsburgh coal to 150′ below that bed.

The *Cornell and Werling mine* (W. H. Brown) is illustrated on plate 522 fig. 75. The pit is a mile from the Youghiogheny river in Logan's Hollow south of Boston, and is largely mined for gas coal for the Cincinnati markets. It is one of the best examples of single entry mines in the district.* The bed shows a roof division of 4′ 2″

*The main entry is quartered, driven S 14° E about 1 mile to Wild Cat Hollow. Face entries are laid at an angle to main gangway, about S 23° W

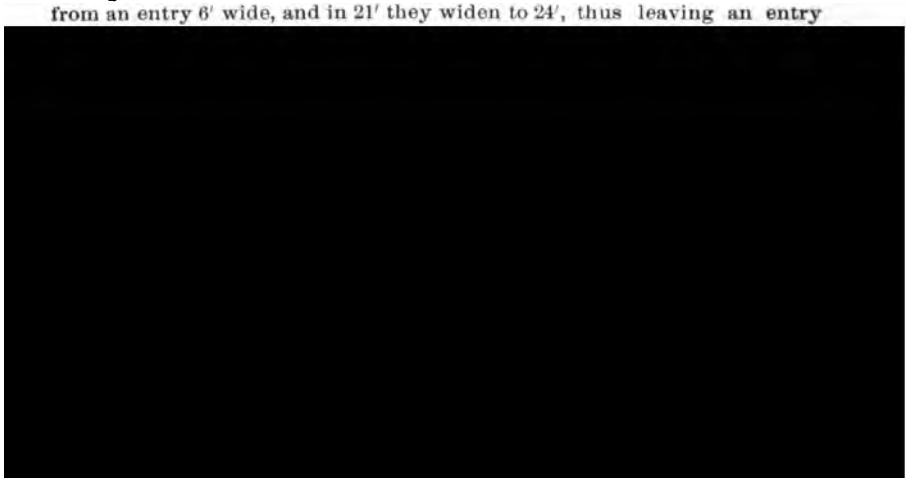
main clay 0′ 8″ and lower bottom 5′ 9″, with benches of 3′ 4″; bearing-in 4″; brick 1′ 2″ and lower bottom 11″. The lower bottom is frequently found clean enough to warrant its being taken up. Horsebacks are met with in the roof members. The O'Neill mine is worked in conjunction with the Cornell and Werling, and shows little or no variation in section.

The *Lovedale* and *Horner and Roberts mines* are on the west outcrop and turn their output into the *Second Pool* on the Monongahela river. The coal dips 75′ per mile southeast. The first named mine is seriously troubled throughout, although the coal is of excellent character. In addition to a large swamp* there is a bad roll in the underclay, bearing north and south through the mine, which has faulted the coal about 2′. The clay swells and lifts the coal on one side and cuts away the coal on the other, highly polishing the fractured edges. In the swamp the divisions are all thicker. The roof division is about 4′ 6″ and main clay 10″. Average of lower division 5′ 5″, with benches of 3′ 0″, 3″, 1′ 0″ and 1′ 2″. Section in swamp 7′ 1″, with benches of 3′ 9″, 6″, 1′ 2″ and 1′ 8″. Clay veins, spars and soot veins are frequently met with.

The *Redstone coal* here and at Hillsdale is about 4′ thick,

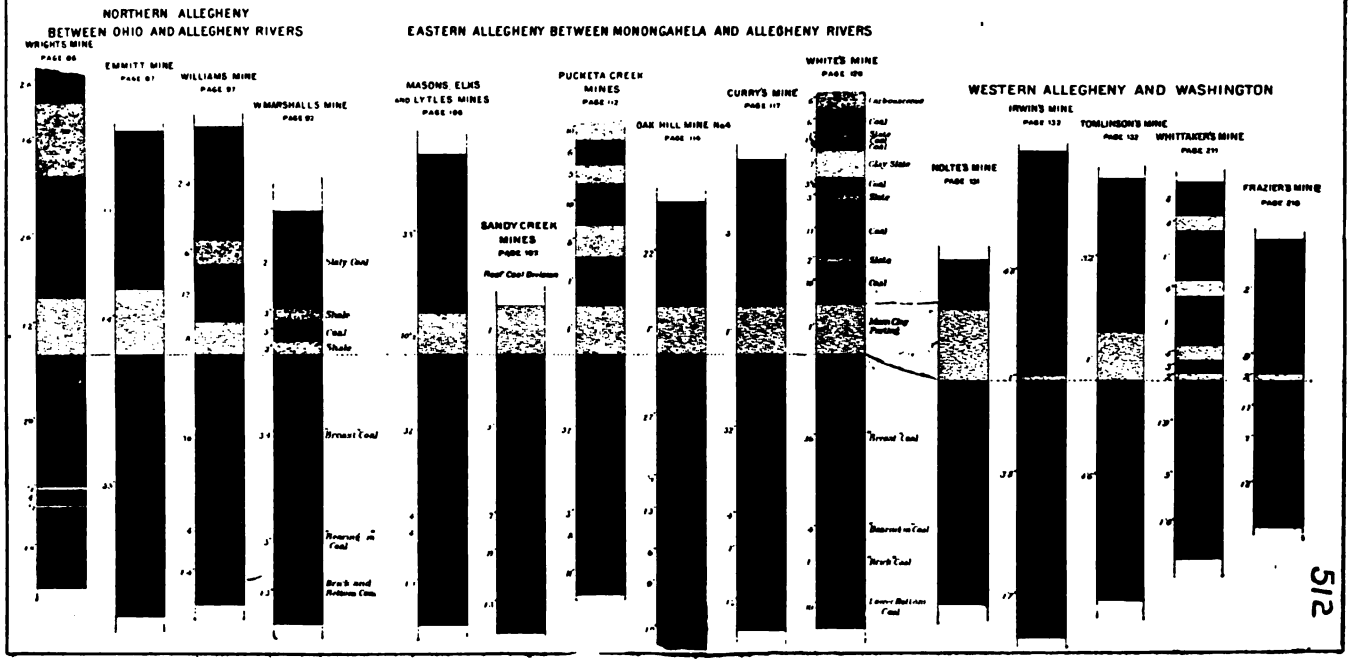
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and 8′ wide, 150 yards apart, from which butt entries are driven S 65° E through the field of coal. Between entries or rooms is 30′. Rooms start from an entry 6′ wide, and in 21′ they widen to 24′, thus leaving an entry



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and to the N. E., around Harmony school house the *Waynesburg coal* is reached.*

Along the eastern border of Elizabeth twp.† the Pittsburgh bed is everywhere above water level, neither of the sub-divisions of the *Waynesburg trough* being sufficiently deep to carry the coal below the Youghiogheny river. Its crop line however, continually approaches the river bank from the north southward, and so feeble is the anticlinal roll between the two sub-basins in this part of the field, that from Buena Vista to the Westmoreland Co. line the coal elevations vary within 30'. Here, north and south of Industry, are located the *Ocean Mines Nos 2, 3 and 4*‡ belonging to the estate of W. L. Scott of Erie, Penna.

Ocean Mines Nos. 3 and 4 are located on either side of a small ravine, and extend northwards to the South-West Gas Coal Co's. tunnel; *Mine No. 2* is an independent opening south of Industry. Swamps have been met with in all three mines which suggest the continuation of the eastern sub-division of the *Waynesburg synclinal* into this part of the district. All these mines and the *Atlantic colliery* to the south are now very extensively developed and furnish a high grade coal. The bed yields about 4' 4" of merchantable coal, the lower division benches being 3' 6", 3½", 1' 0" and 1' 0", with the main (breast) coal occa-

*The Round Hill church is on upper or Uniontown div. of Great Limestone, 12' to 14' thick, with Uniontown coal above it, while road intersection, about 40' below church, is in lower div. This limestone must be quite thick, (80' to 100').

The *Sewickley coal* crop is marked by about 1' of carbonaceous matter. Beneath it sandstone and sandy shales for 25', and then Fishpot limestone, about 10'. Below this sandy shales again occur to the *Redstone coal*, about 4' thick. The coal is slaty and evidently worthless, and lies about 60' above Pittsburgh coal.

† Nowhere between this point and Pittsburgh does the great commercial bed of the region reach the same favorable relation to water and railroad levels. The inclines are short and grades favorable, the coal acreage comparatively compact and regular, and with the high reputation of the "*Youghiogheny Gas Coal*" already established, this section seems to be exceedingly favored.

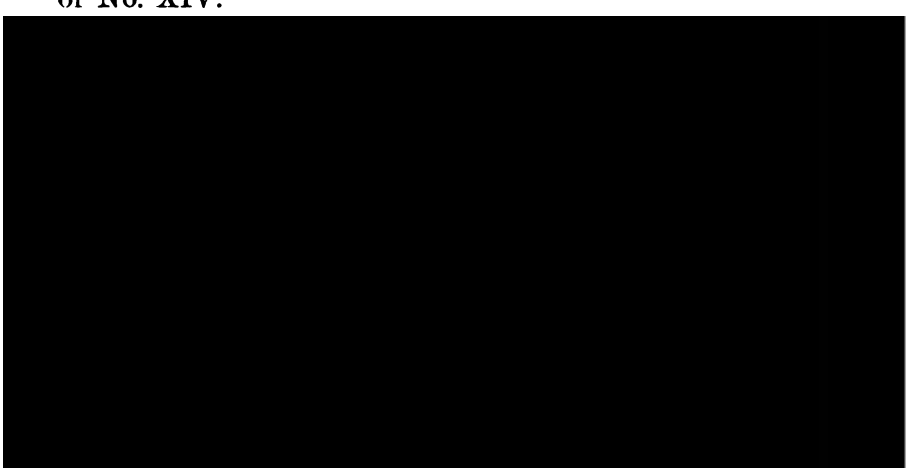
‡ Ocean Mine No. 1 is located on opposite side of river in Westmoreland Co., at Scott Haven, where lower division shows benches of 3' 8", 4", 1' and 1'.

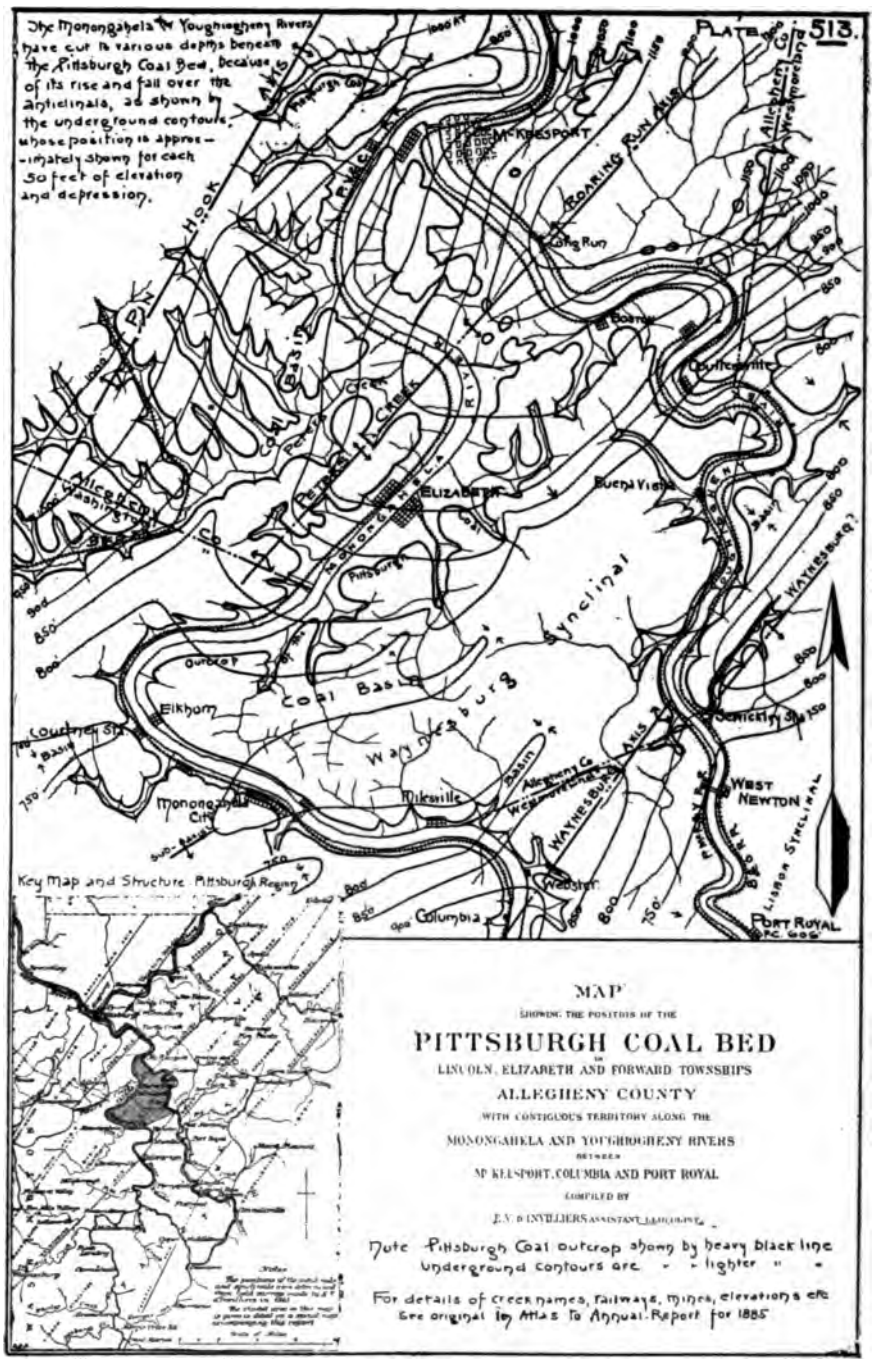
sionally carrying 2″ bone coal on top. Along Howell's run and contiguous territory the full character of the bed is shown by the following section:

Roof Division	*Coal*	0′	10″	to	0′				
	Clay	1	0″	to	1	2″	3′	10″	to 4′ 4
	Coal	2′	0″	to	2′	2″			
Main clay parting,							0′	10″	to 1′ 0′
Lower Division	*Breast coal*				3′	6″			
	Bearing-in coal,	0′	2″	to	0′	4″			
	Brick coal				0′	11″	5′	6″	to 6′ 0′
	Lower Bottom coal,	0′	11″	to	1′	2″			

The roof coal, as usual, is unfit for mining; the brick coal very good throughout; the bottom coal worthless and the breast coal sometimes divided by a thin band of pyritous slate.

Forward twp. lies next to the south-west. Its geology is but a south-eastern prolongation of that of Elizabeth twp., except that the general south-west inclination of the measures has buried the Pittsburgh bed under still more cover in the Waynesburg trough. However, the combined effect of the axis to the north-west of the township limits, and the erosion of the Monongahela river, has resulted in the uninterrupted exposure of the great coal bed along the river, from Falling Timber run and Elizabeth on the north to the Westmoreland Co. line on the south * The section exposed extends from 280′ above the Pittsburgh coal to 200′ below, to the bottom of the *Morgantown sandstone* of No. XIV.




The Monongahela & Youghiogheny Rivers have cut in various depths beneath the Pittsburgh Coal Bed, because of its rise and fall over the Anticlinals, as shown by the underground contours, whose position is approximately shown for each 50 feet of elevation and depression.
McKEESPORT
Elizabeth
Buena Vista
Pittsburg
Elkhorn
Coal Basin
Syncline
Waynesburg
Millsville
Monongahela City
Columbia
WEST NEWTON
PORT ROYAL
Key Map and Structure Pittsburgh Region
MAP
SHOWING THE POSITION OF THE
PITTSBURGH COAL BED
IN
LINCOLN, ELIZABETH AND FORWARD TOWNSHIPS
ALLEGHENY COUNTY
WITH CONTIGUOUS TERRITORY ALONG THE
MONONGAHELA AND YOUGHIOGHENY RIVERS
BETWEEN
McKEESPORT, COLUMBIA AND PORT ROYAL
COMPILED BY
E.V. D'INVILLIERS ASSISTANT TOPOGRAPHER
Note Pittsburgh Coal outcrop shown by heavy black line
Underground contours are - - lighter " "
For details of creek names, railways, mines, elevations etc
See original by Atlas To Annual Report for 1885

The *Uniontown coal and limestone* are reached in several places, south of Elizabeth and Perry's Mill and Leech runs and the lower division of the Great Limestone 60′ thick along the river hills. The *Sewickley coal* is wanting; but the *Redstone bed* is opened in better condition than to the north and on Fallen Timber run shows 3′ to 4′ thick and quite clean and pure.

The *Horner and Roberts mine* at Hilldale is the largest mine in the district and shows best the typical character and variation of the Pittsburgh coal. Sections of the average and "swamp" coal are given on plate 524 figures 46 and 47. The page plate illustration 513 also shows the underground structure of the bed here and the sinuous course of a long swamp, where 2000′ from the pit mouth the coal has fallen 82′ from the crop. In the butt entries extending out of this swamp the initial rate of rise is very rapid, outside of which limits the dip is quite regular. The swamp is estimated to be 300 yards wide and 10 yards deep.

In the pump shaft 133′ 6″ deep the coal is struck in the swamp, swollen to 10′ 5½″, of which the roof division is 2′ 3″; main clay 11″ and lower division 7′ 3½″, with coal benches 4′ 6″, 3″, 1′ 0″ and 1′ 6″. Outside the swamp areas the mining divisions show breast coal 2′ 10″ to 3′ 2″; bearing-in 0′ 3″ to 0′ 4″; brick coal about 1′ 0″ and lower bottom coal 1′ 1″ to 1′ 4″. Clay veins were seen in the water course gangway, between Nos. 7 and 8 entries, running in every direction and sometimes crossing one another. They generally thin out towards the swamp, only 3″ out of 18″ or 20″ in the water course gangway being prominently seen there. Some are white clay; others a heavy, hard, black spar.

The *Pittsburgh bed*, on McKinney's Fork, shows about 3′ of coal in the roof division, and 5½′ in the lower division; but both the "brick" and "lower bottom" members are frequently sulphurous.

The *Wenona mine* (see plate 510) shows the mining coal 5′ 10″, furnishing 4′ 8″ coal and leaving 1′ 2″ in bottom.

The *Old Eagle mine* at Elkhorn is also illustrated on plate 510. This mine was opened about 35 years ago, and owing

to its position, right in the axis of the north sub-division of the Waynesburg basin, its development has presented many interesting features of the characteristic structure of the Pittsburgh coal when similarly situated in troughs or swamp lines, and illustrates the great irregularity of the floor of this bed. The swamp has been developed for about 650 yards, 200 yards wide and 10 yards deep, really a separate basin. The breast, bearing-in and some of the brick coal are mined in this pit in one bench 4′ 2″ to 4′ 10″ thick.

A compressed air locomotive (see plate 501) has been used here for a number of years, notwithstanding great irregularities of dip in the coal, for delivering cars from the main parting inside the mine to the river tipple.

The *Rankin and Milesville* mines further up the river and near the Westmoreland Co. line amplify the illustrations already given. The former opening marks the bottom of the southern "swamp" or sub-division of the Waynesburg basin, which bears about N 58° E to Suter on the Youghiogheny river. The coal mined is 4′ 6″ thick, leaving 1′ 6″ of lower bottom in floor. Becket's run, to the south of the Milesville mine, marks a line of fault, bearing N 40°–45° E, dropping the coal on the west side about 20′.*

No. XV in the Pittsburgh District, south and west of the Monongahela River.—Allegheny, Washington and Greene Counties.

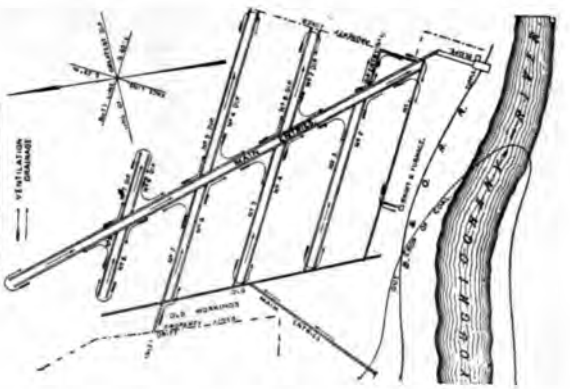


PLATE 514

Nº XV Monongahela River Series S.W. Penn.a

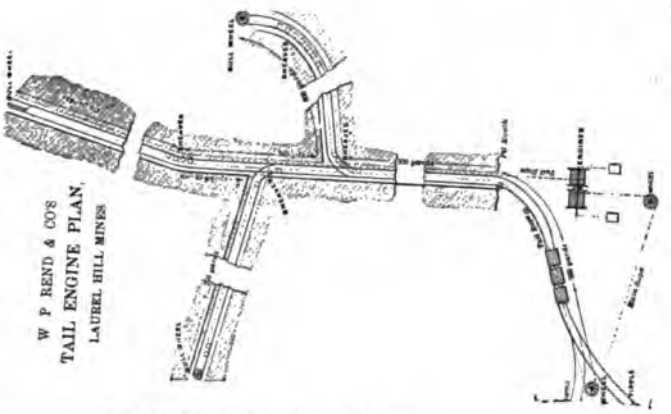
Youghiogheny River

YOUGHIOGHENY SLOPE MINES
NEAR
West Newton.
B. & O.R.R.
McCULLY & TAYLOR.



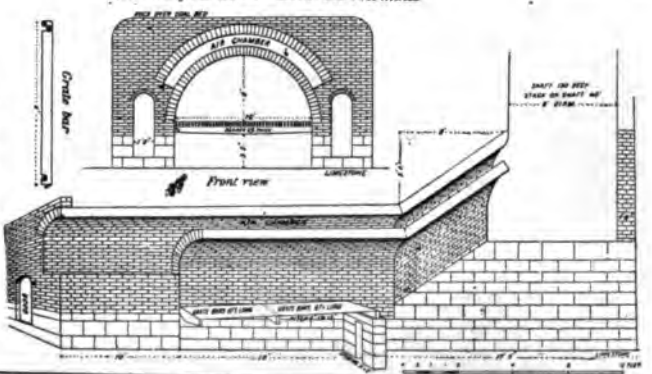
Panhandle District

W P REND & CO'S
TAIL ENGINE PLAN,
LAUREL HILL MINES



Monongahela River

Ventilating Furnace at Waltons 2nd Pool mines



the bulk of the enormous annual tonnage passing through the locks of the Monongahela Navigation Co. originates.

Plate 519 shows a key map of the eight pools and a list of the principal mines in this district, shown in more detail in the suite of six sections on plates 520 and 521. The general map, plate 475, showing the entire area underlaid by the *Pittsburgh coal west of Laurel Hill*, will closely indicate the importance of the field which is tributary to the Monongahela River district, now to be described.*

Beginning at the north, in the region immediately south of Pittsburgh, there is an important group of mines along *Montours run*, the *Panhandle R.R.* and *Chartiers Creek* and *Saw Mill run* whose coal is largely shipped by rail or dropped directly into Ohio river barges, *below* Lock No. 1, in west Allegheny and north Washington Cos. In southern Beaver there are a few remnants of the Pittsburgh coal still left to indicate the outspread of the Upper Productive Measures.

East of Frankfort along the Washington Co. line the coal as mined by Mr. Cooley† shows a roof division of 3′ 3″ consisting of two benches, 2′ 6″ and 4″, separated by 5″ of clay; a main clay parting of 0′ 6″ and a bottom bench of 6′. The breast coal (3′ 1″) carries 3″ of slate 2′ 1″ from top, the bearing-in coal and partings 5″, and the two lower benches 2′ 6″. The breast coal mines out in rectangular blocks, and can be used for smithing; but the best coal comes from the bearing-in bench, which is clean and free from sulphur. About 1′ 6″ of the brick and bottom coal are raised, below which the coal is impure. Further contrasts are furnished by small openings in Hopewell twp. *Cortney's bank*, 600′ above the Ohio river, shows a roof division of 4′ 9″ with

* Plates 509–512 and 522–526 give vertical sections of Pittsburgh coal at different mines in this district. For details concerning mines and general geology see Reports K and K 4 and Annual Reports for 1885 and 1886.

† *Babbett's mine*, 1 mile east, shows a section in striking contrast with Cooley's, with roof div. 6″, one-half coal; main clay 1′ 4″ and lower div. 4′ 4½″ with benches of 2′ 8″, 3½″ and 1′ 5″. The *Leiper bank*, 1 mile northwest of Frankfort, shows roof 2′ 3″; clay 1′ 2′ and lower div. 4′ 6′; the breast coal still divided near centre by 3″ of clay. These are all country pits, and merely serve to illustrate the condition and section of the bed near western outcrop.

several partings; main clay only 2″; lower division thinned down to 3′ 10″, the bearing-in coal and slates near the centre 5½″ thick. The coal has but little cover, and is generally poor and slaty.

In Washington Co. the Pittsburgh coal is generally under water level *south* of the Panhandle R. R., except for a short distance on Cross creek and Scotts run along the Ohio line and along Chartiers creek under the Washington and near the Claysville axes.

In Hanover twp., along the Beaver Co. line, there is a considerable area of irregular shape around Florence and Bavington west of Raccoon creek in which there are numerous country pits, and where the section extends up to the *Great Limestone.* The dip is south-east. A group of five mine sections here is shown on plate 512 of which the following table shows the variation in north Washington :—

Locality.	Roof Division.	Main Clay.	Lower Division.		
			Breast.	Bearing-in.	Brick & Bottom.
John Frazier,*	2′ 9″	0′ 2″	1′ 1″	0′ 3″	1′ 8″
School No. 5,†	Sandstone		1′ 10″	0′ 4½″	0′ 10″ 0′ 10″
Florence,‡	1′ 8′		1′ 3″	0′ 5½″	1′ 1″ 0′ 6″
Russell,§	8′ 5″	0′ 10″	3′ 4″	0′ 3″	5″–8″ 1′ 0″
Whittaker,‖	2′ 1″	0′ 2″	1 9″	0′ 5″	1′ 6″
Eldersville,**	5′ — 8′	0′–1′	2 8½″	0′ 4″	1′ 0″ 1′ 2″
Cross Creek,††			2′ 5″–2′ 7″	0′ 4″	1′ 10″–2′ 2″
Patterson, ...			2′ 6″	0′ 4″	2′ 0″

PLATE 515.

Electric Coal Mining Machinery.

1 Jeffrey Mfg Co Electric Hoist.



2 Jeffrey Mfg Co Chain Coal Cutter Side View.

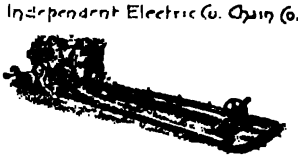


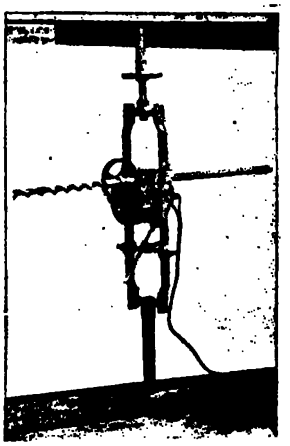
3 Jeffrey Chain Coal Cutter. End View

4 Jeffrey Rotary Coal Drill



5 Independent Electric Co. Chain Coal Cutter





EVd'l.

The *Panhandle* and *Chartiers Valley districts* in Allegheny and Washington Cos. are illustrated in page plate 511 by 10 sections. The following table shows the variations of the *Pittsburgh coal bed:*

Locality.	Roof.	Main clay.	Lower Division.			
			Breast.	Bearing-in.	Brick.	Bottom.
Mansfield,	2′ 0″	0′ 10″	3′ 0″–3′ 6″	4′ 7″	0′ 9″–1′ 0″	1′ 0″–1′ 6′
Grant,	. . .	. . .	2′ 10″	0′ 3 ′	0′ 8″	1′ 0″
Ewing,	. . .	. . .	2′ 8″	0′ 3″	0′ 8″	1′ 0″
Federal Spring,*	1′ 5″	1′ 0″	2′ 9″	0′ 3″	0′ 10″	0′ 8″
Oak Ridge,†	0′ 9½″	0′ 7½″	2′ 6½″	0′ 3½″	0′ 10″	1′ 1″
Laurel Hill,	1′ 2′	0′ 7″	*Block coal* 4′ 6″			
Jumbo,‡	. . .	. . .	*Block coal* 4′ 2″ to 4′ 10″			
Primrose,§	. . .	. . .	2′ 9″–3 6″	0′ 4½″	0′ 8″–1′ 3″	0′ 9″–1′ 6 ·
Midway,	. . .	. . .	*Block coal* 4′ 6″ to 5′ 0″			
Fox,	5′ 4″	1′ 0″	3′ 0″	0′ 4″	0′ 10″	1′ 4″
Phoenix,	1′ 5″	0′ 9″	3′ 4″	0′ 4″	1′ 8 ′	
P. C. & Y. tunnel,	3′ 9″	1′ 0″	2′ 8″	0′ 3″	1′ 6″	
Bridgeville,	1′ 7″	0′ 10″	3′ 2″	0′ 3″–0′ 5″	0′ 9″	10″–1′ 0″
Allison,	0′ 11″	0′ 2″–2′	3′ 0″	0′ 2″–0′ 5 ′	0′ 1″	1′ 0″
Thompson,	0′ 10′	0′ 2″–2′	3′ 0′	0′ 3″	1′ 6″	1′ 0″

A very large number of mines and country pits occur within this special district; but the above have been selected for illustration with a view of representing the average condition of the Pittsburgh coal here. The *roof division* is quite variable and is always worthless. The *lower division*

*In *Cannonsburg district*, Chartiers twp. commercial coal about 4′ 6″ thick; at Allison mine about 4′. The Challenger pit shows lower div. 5′ 2″ to 6′ 2″; breast coal 2′ 10″ to 3′ 6″. Roof coal quite thin, in places only 2″ thick. † *Oak Ridge mine*, west of Greggs Sta., Allegheny Co. works through a long tunnel, and in swamp entry in second hill, coal is 5′ thick. Elsewhere average thickness is 3′ 4″, but good throughout. The *National Coal Works*, further west, show a similar lower div., the roof coal being in places 7′ thick. ‡ *Jumbo mine*, Washington Co. on Panhandle R. R. developed by coal cutting machines, man labor and an extensive wire rope system. Bearing-in is done on top of limestone, thus taking out whole bed. Coal averages 4′ 6″, being 4′ 10″ at pit mouth, and 4′ 2″ at head of tunnel. So far as developed all the coal has a *block character*, and a small slate, occurring about 4″ above bottom, is frequently used for bearing-in by the hand laborer. The swamps met with are small. § *Primrose mine* further west is developed by bearing-in above bands and only occasionally is brick coal found sufficiently clean to mine. Front coal was largely *block*, open burning and semi-cannel in structure, and without separate benches. There was comparatively little of this coal however, and in rear workings, clay veins and horse backs are frequent.

furnishes about 4′ to 5′ of merchantable coal, the bottom member of the bed being usually impure and left in the mine. Frequently this entire lower division becomes a "*block coal*," without visible partings, especially along the Allegheny–Washington line between McDonald and Midway stations.

The Mansfield Coal & Coke Co. mine north-westward towards the Claysville axis, the coal rising up Campbell creek 50′ to 60′ per mile. The slack from this mine is washed and coked, and though the coke is somewhat soft, it is largely used in the western markets for mill and foundry purposes.

The *Grant mines*,* further up Robinson's run and close to the Mansfield synclinal, yield about 3′ 6″ of commercial coal, which is a full average for a number of mines in this vicinity.

Along the P. C. & Y. R. R. in Allegheny Co. the outcrop extends along Chartiers creek from Mansfield to below Hastings Sta., the coal lying very flat owing to the course of the stream, though rising more directly south-east to the Washington axis. In Washington Co., this same axis elevates the coal from Cannonsburg to Ewingsville, while it crops completely across the *Mansfield basin* towards McConnells mills and the Claysville axis.

In *S. Fayette twp.* a large area of coal owned by the *Chartiers Block Coal Co.* occurs along Thoms run, furnish-

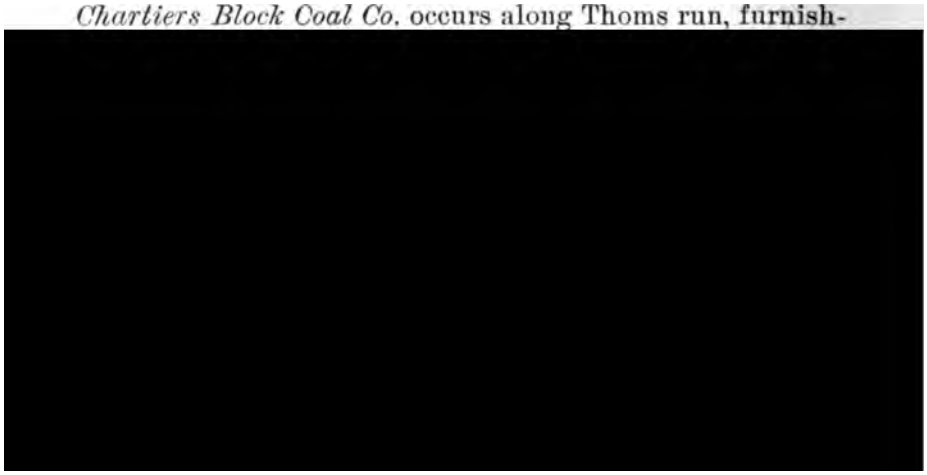


PLATE 516.

Electric Coal Mining Machinery.

Types of Mine Locomotives.

1 Sprague Mine Locomotive

4 Independent Electric Co. Mine Locomotive.

2 Jeffrey Mine Locomotive. Inside Wheels.

3 General Electric Co. Mine Locomotive

Eng'd.

in the district, opened a short distance below McDonald station. The front coal is about 1040′ A. T., the main entry going in on true butt and dipping for 1600′ to a swamp. A swamp entry connects the old workings at this point by which the water is collected on the main entry and pumped from there out to main pit mouth. In this mine especially in the new pit, the miners bearin on the bottom limestone, or within 2″ of it, thus obtaining from 4′ to 6′ of coal. The breast varies from 3′ to 4′ thick.

The *Laurel Hill mines* are probably the largest operation along the Panhandle R. R. Haulage system is shown on plate 514.

The main coal varies from 4′ 6″ to 6′ 3″, averaging a little over 5′. Bearing-in is done on the limestone, using largely machine cutters. The front coal is all block; all members are equally good and the bearing-in slates thin and insignificant (plate 511).

Further in the hill, where the *block coal* changes to *bench coal*, the breast and bearing-in furnish about 4′ and the bottom coal 1′ 2″ to 1′ 6″. Here too "black jack" or "nigger head" becomes a troublesome impurity.

Limited outcrops of the Pittsburgh bed occur to the south-east on Miller's creek waters, sufficient to afford access to the south Fayette territory. This is an excellent field of undeveloped coal, and from its superior position and availability, must soon command attention. A great deal of the coal, like that along the Panhandle, is of *block* nature, the whole lower division being without partings or benches. While of course development has proved, in the larger mines of the township, that the character of the coal is very liable to change into the characteristic "bench" form of the Pittsburgh bed, the coal, when so changed, is quite as valuable though a more common commodity.

The *Hastings mine* on the P. C. & Y. R. R. reaches the Pittsburgh coal by a slope 125′ long and 33′ deep. The coal section shows roof division 5′ 4″; clay parting 6″; lower division 5′ 10″. The lower bottom averages about 1′ 4″ and is not mined. The balance 4′ 6″ is most excellent coal.

Passing Hastings station, and the anticlinal, the dip along the creek is south-east all the way to the Washington line.

The *Midway mines** are worked from a shaft and operated on both sides of the railroad. The workable portion of the bed 3′ 6″ to 4′ 0″ thick, shows no partings and is a true block coal, yielding masses of any desired size. Beneath this 1′ to 15″ of bottom coal is too impure to mine. The coal is more than semi-cannel, but contains bituminous coal in thin streaks. It is extremely clean and pure.

Along Montour's run the *Cliff* and *Montour mines* of the *Imperial Coal Co.* are the principal operations. The *Montour mine*† is located close to the Bulger axis, the front coal *rising* south-east to the pike and then *dipping* south-east to Robinson's run. The breast coal varies from 2′ 8″ to 3′ and brick coal 10″ to 1′ 0″, the average yield of commercial coal being 3′ 8″ to 4′ 10″.

The *Cliff mine* lies south-east of the axis, its breast coal 3′ and brick 10″. The roof coal in both mines is over 4′.

Around Sharon in Moon twp. there is a long narrow strip of the Pittsburgh coal extending south-east nearly to Montour's run. In its best shape the coal shows a breast coal bench of 3′ 1″, with 1″ of parting 10″ from top; bearing-in coal and bands 0′ 6″; brick 0′ 9″ and lower bottom 1′ 6″. The roof division reaches 3′ 9″ and main clay 10″. The *McCormick* and *Nolte mines* yield a lower division of 4′ 10″ and 4′ 7″. (See plate 512).

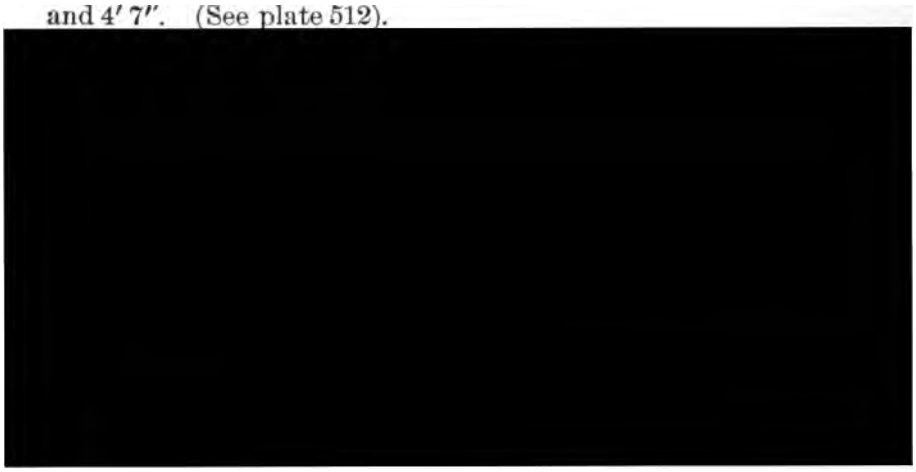
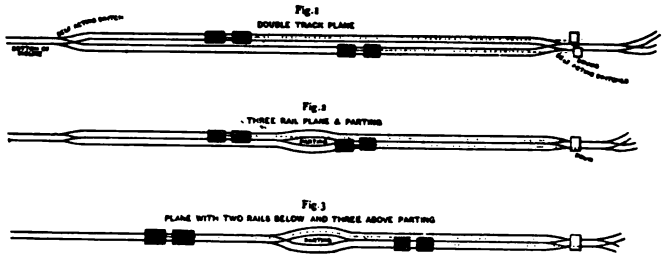


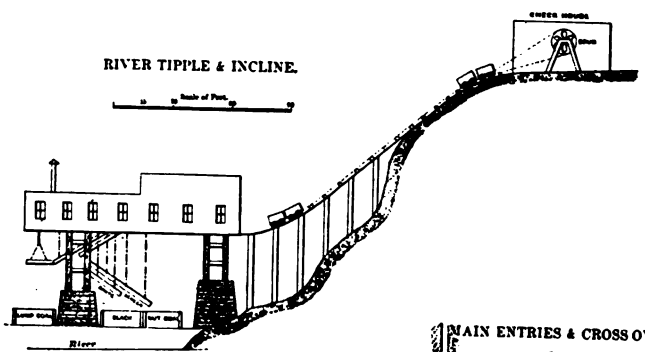
PLATE 517.

XV. Pittsburgh bed mine machinery.

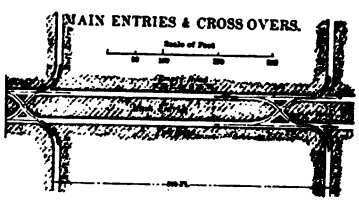
THREE KINDS OF GRAVITY PLANES.



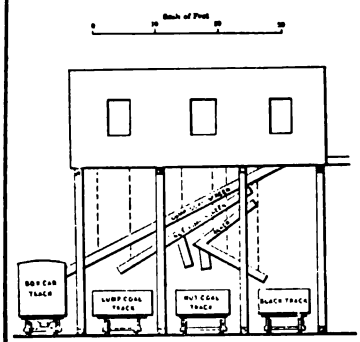
RIVER TIPPLE & INCLINE.



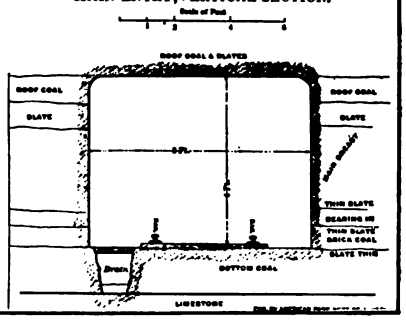
MAIN ENTRIES & CROSS OVERS.



RAILROAD TIPPLE



MAIN ENTRY, VERTICAL SECTION.



4′ 8″; clay parting 0′ 1″ and lower division 5′ 3″. The breast coal is here 3′ 8″ thick, though in this field it rarely exceeds 2′ 9″. The coal is soft and free burning and is free from clay veins and horsebacks. The *Tomlinson mine* in the south-east corner of the township shows roof 3′ 2″; main clay 1′ 0″; lower division 4′ 6″, excellent for steam purposes, free burning and low ash. The *Cox bank* at North Star, shows roof 5′ 10″; clay 1′ 0″; bottom 4′ 9″.

Mines along Saw Mill run; below Pool No. I.

Immediately south of Pittsburgh a large amount of coal has been won along the two branches of Saw Mill run, the Pittsburgh coal cropping along the river front at elevations of over 1000′ above tide, and sinking gently south-west on both sides of the Washington axis, where its outcrop is eroded up to Castle Shannon. All these mines have furnished the very best quality of coal, more largely used and preferred in the Pittsburgh market than any other, although now largely exhausted along the immediate river front. Typical sections of the seam (see plate 522 figs. 67, 68, 69) are shown at the following mines:—

Locality.	Roof Division.	Main Clay.	Lower Division.			
			Breast.	Bearing-in.	Brick.	Lower Bottom.
Castle Shannon,*	2′ 3″	0′ 10″	3′ 0″	0 3″	1′ 0″	1′ 2″
Enterprise, † . .	1′ 9″	0′ 10″–1′ 6″	3′ 3″	0′ 4″	0′ 10½″	1′ 4″
Venture, ...	3′ 0″	0′ 10″	3′ 3″	0′ 4″	1′ 0″	1′ 2″
Fox, ...	4′ 2″	0′ 9″–2″ 6″	3′ 3″	0′ 4½″	0′ 9″	1′ 2″

* *Castle-Shannon mines* are located up a branch from Stone House at about 975′ A. T. the coal rising north-west to 981′ in West Liberty borough, and north-east to 991′ in bluff back of Bell House. The larger part of these hills are worked out of available coal, and numerous gob piles along the streams attest former activity of region. Horizon of *Great Limestone* is frequently met with in hills between outcrops of Pittsburgh coal; but with the exception of region bordering Baldw-in and Scott this great calcareous formation can rarely be recognized. It seems to have turned almost entirely into shales. The *Pittsburgh* (upper) *sandstone* is likewise thin and disintegrated.

† *Enterprise mine* enters crop where coal goes under water level at Banks-

Nearly all these mines have extended their entries far to the south-west, drawing their coal practically from the same region as supplies Pool No. 1. The crop has been punctured at scores of old openings, but most of the available coal north from Greentree borough has been removed. The *Venture* and *Chess mine* workings are connected and have yielded about the same character of excellent coal in the past.

Mines on Pool No. 1, south and west of the Monongahela river.

This pool embraces the territory between the first and second dams of the Monongahela Navigation Co., extending from Pittsburg to Port Perry. Out of a large number of mines shipping either directly by river or by the Becks run, Baltimore & Ohio and Whiteacre run railroads, the following have been selected as types of the Pittsburgh coal (Plates Nos. 522 and 523).

Locality.	Roof Division.	Main Clay.	Lower Division.			
			Breast.	Bearing-in.	Brick.	Bottom.
Green Springs,	4′ 8″	0′ 10″	3′ 2″	0′ 4½″	0′ 9″	1′ 4″
Bellwood, . . .	3′ 0″	0′ 4″–0′ 8″	3′ 2″	0′ 5″	0′ 10″	1′ 1½″
Hays, . . .	4′ 4″	0′ 8″	3′ 0″	0′ 5½″	0′ 9″	0′ 3″
Street's Run,						
Risher, ...	4′ 7″	0′ 9″	3′ 2″	0′ 4″	0′ 10″	1′ 2¼″
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[redacted]

No XV. Pittsburgh Bed along the Monongahela River.
PLATE 518.
COAL WORKED OUT
TOWN OF W. ELIZABETH
LOCOMOTIVE ROAD
COAL WORKED OUT
NO COAL
NO COAL
GEOLOGICAL SURVEY OF PENNSYLVANIA.
J. P. Lesley, State Geologist
E. V. d'Invilliers, Asst. Geologist.
MAP
of the
SECOND POOL MINES
of
JOS. WALTON & CO.,
West Elizabeth, Penna.
BY SIDNEY TAYLOR.
NOTES
SCALE 2000 FT TO AN INCH

All these mines are in Baldwin and Mifflin twps., Allegheny Co., and give abundant evidence of the great regularity of the lower division; the most uniform thickness of the mining members, and the greater variation and thickness of the roof division. It must be remembered that the latter is nowhere mined and is split up into thin benches by numerous slates.

Walton's Six Mile Ferry works enters the crop nearly 300′ above the river, and its section is typical for this region in the *Nineveh basin.* One swamp passes through the mine about 800 yards from the pit mouth and 15′ deep, and slopes downward northwest, causing a dip in that direction along the rear tunnel.

Along the Wheeling Division of the B. & O. R. R. the country rises to 250′ above the Pittsburgh coal, showing imperfect exposures of the Great Limestone.

In Mifflin twp. the Pittsburgh coal is opened in nearly every ravine. Along Streets run the *McKee coal* shows roof division 3′ 4″ to 3′ 6″; clay parting 6″ to 8″; lower division 5′ 1″. The roof coal is generally bony and dull. The lower bottom coal 1′ 1″ thick, is worthless, leaving 4′ of breast and brick.

Proceeding northwards along Streets run the coal is found always rising along a line parallel with the axis, as well as to the south-east towards the *Pinhook anticlinal.* Thus openings have been made in four places and the three most northern gangways have been carried to daylight in Hamilton hollow south-east.*

---

entry south-west to Saw Mill run, where the Jones and Laughlin *American mine* and the *Bimingham Coal Co's.* mine also concentrate. Breast coal may average 3′ 6″; bearing-in 4″ and brick 9″ to 1′, so that the commercial portion of the bed yields about 4′ 6″.

*The most northern is 1890′ long S 65° E, and shows no difference of level at the ends. For 1250′ from west opening, coal dips 9′ to centre of swamp and apparently near its head.

The second butt entry is 2930′ long, centre of swamp being 2150′ from Streets run crop and 12′ lower; further south in third parallel butt entry, 2760′ long, swamp is 7′ lower than west opening and 1600′ S 65° E from it. The curious feature of this swamp is its greater elevation in the central gangway, which however can be readily overcome and the entire swamp drained out at 975′ A. T.

The *Green Springs mine** has been among the most extensive on the river, and lies on the east side of the Pin Hook axis. The roof coal is about 5′ thick, but as usual through this region, utterly worthless, occurring in seams between slate and clay, rarely over 6″ thick. The main over-clay is reported regular throughout the mine; the rolls and horsebacks occur in the roof members with a tendency to compress the breast coal slightly from 4″ to 6″. The bottom coal is not lifted. The bed will not yield much over 4′; but by an extensive system of wire rope haulage, a large output of most excellent coal is economically secured here, the coal bed being comparatively undisturbed and free from swamps or clay veins.

Mines in Pool No. 2 in Allegheny County.

Pool No 2 extends along the Monongahela river from Port Perry to the Washington Co. line, embracing the areas in Mifflin, Jefferson and Snowden twps., as well as the territory along the lower end of Peters creek and along Lick run and the B. & O. R. R. The Pin Hook axis fairly limits the western extension of mining for the river trade and some of the mine entries have really been extended from the river up the rise of the coal to and across this axis.

There is a long list of operations tributary to this pool, fairly illustrated on plates 524, 525, and 526 of which the following may be taken to represent the *average condition* of the Pittsburgh coal :



PLATE 519

No XV. Pittsburgh District. Mines in the Monongahela River Pools.
From the West Virginia State Line to Pittsburgh (See Plates 520 & 521.)

Key Map.
Plates 520 and 521.



Mines on Pool No. 6.

1. Cat's Run mine,
2. Jacobs' Slope mine,

Mines on Pool No. 5.

3. Evans mine,
4. Maple Glen mine,
5. Black Hawk mine,

Mines on Pool No. 4.

6. Knob mine,
7. Bridgeport Slope mine,
8. Umpire mine,
9. Climax mine,
10. Garrow mine,
11. Cedar Hill mine,
12. Little Alps mine,
13. Merchant mine,
14. Greenfield mine,
15. Reed mine,
16. Globe mine,
17. Dexter mine,
18. Eclipse mine,
19. Caledonia mine,
20. Champion mine,
21. Wood's Run mine,
22. American mine,
23. Peacock mine,
24. Snow Hill mine,
25. Bargedde mine,
    Hoaf coal lots,
26. Stimmel mine,
27. Furlong mine,
28. Troytown mine,
29. Turnbull & Hall mines,
30. Carondelet mine,
31. Little Redstone mine,
32. Connecticut mines,
33. Clipper mine,
34. Ashmaid mine,
35. New Tremont mines,
36. Old Tremont mines,
37. Little Pittsburgh mine,
38. Taggart mine,
39. Glass Works mine, No 1,
40. Glass Works mine, No. 2,
41. Speer's mine,
42. Rostraver mine,

Mines on Pool No. 3.

43. Wolf Harbor mine,
44. Whitesville mine,
45. Boyle mine,
46. Myers mine,
47. Jacksonville mine,
48. Welsh mine,
49. Iron City mine,
50. Thomas mine,
51. Columbia mine,
52. Webster mine,
53. Gilmore mine,
54. Bissel mine,
55. Heslep mine,
56. Paynetown mine,
57. Bakertown mine,
58. Becketts' Run mine,
59. Stockdale mine,
60. Baird mine,
61. Milesville mine,
62. Harlem mine,
63. Victory mine,
64. Wier mine,
65. Rankin mine,
66. Robinson mine,
67. Black Diamond mine,
68. Fort Pitt mine,
69. Ivile mine,
70. Old Catsburgh mine,
71. New Catsburgh mine,
72. Bakewell mine,
73. Dry Run mine,
74. New Eagle mine,
75. Mingo mine,
76. Mure mine,
77. Old Eagle mine,
78. Courtney mine,
79. Black Hills mine,
80. Barr mine,
81. Garfield mine,
82. Holmes mine,
83. Buffalo mine,
84. Lysle mine,
85. New Cincinnati mine,
86. Britton mine,
87. McKinney mine,
88. Jesse Bentley mine,
89. Old Cincinnati mine,
90. William Finley mine,
91. Port Finley mine,
92. H. H. Finley mine,
93. John Finley mine,
94. Chester mine,
95. Cox mine,
96. Hughes mine,
97. Craig mine,
98. Jenkins mine,
99. French mine,
100. Hutchinson mine,
101. New Coal Bluff mine,
102. Reed mine,
103. Peterson mine,
104. Coal Bluff mine, No. 3,
105. Coal Bluff mine, No. 2,
106. Coal Bluff mine, No. 1,
107. Cliff mine,
108. Irwin mine,
109. Absalom Bentley mine,
110. Banner mine, No. 1,
111. Banner mine, No. 2,
112. McKnight mine,
112a. Park mine,
113. Wenona mine,
114. Locust Grove mine,
115. Hilldale mine,

Mines on Pool No. 2.

116. Upper Walton mine,
117. Jones mine,
118. Walker mine,
119. Harvey O'Neil mine,
120. Lower Walton Mine,
121. West Elizabeth mine,
122. Horner & Roberts mine,
123. Lovedale mine,
124. Bellevue mine,
125. Robbins & Jenkins mine,
126. Blackburn mine,
127. Pine Run mines,
128. Rock Run mine,
129. Allequippa mine,
130. Camden mine,
131. Amity mine,
132. Hunter mine,
133. Dravosburg mine,
134. Stone's mine,
135. Blackstock mine,
136. Gallatin mine,
137. John Neel mine,
138. Dunshee mine,
139. Whigham mine,
140. Collins mine,
141. Crawford mine,
142. James Neel mine,
143. McCloskey mine,
144. Saltworks mine,
145. Keystone mine,
146. Corry mine,
147. Shaw mine,
148. Port Perry mine,
149. Miller mine,

Mines on Pool No. 1.

150. Turtle Creek mine,
151. John Robison mine,
152. Kenny mine,
153. Greensprings mine,
154. Braddock mine,
155. Bellwood mine,
156. Brown mine,
157. Hodgson mine,
158. Bushnell mine,
159. Hays' Street's Run mine,
160. Risher mines,
161. Walton's Pool No. 1 mine,
162. Beck's Run mines,
163. American mine,
164. Ormsby mine,
165. Bausman mine,
166. Castle Shannon mine,

Saw-Mill Run Mines.

167. Enterprise mine,
168. Venture mine,
169. Coal Ridge mine,
170. Eclipse mine,
171. Chess mine,
172. Fox mine,

Peters' Creek Mines.

173. Venetia mine,
174. Lockhart mine,
175. Legler mine,
176. Peters' Creek mine, No. 1,
177. Peters' Creek mine, No. 2,

Youghiogheny River Mines.

178. Miller mine,
179. Edmundson mine,
180. Penny mine,
181. James O'Neil mine,
182. Cornell & Werling mine,
183. Osceola mine,
184. Alpsville mine,
185. Eagle Nest mine,
186. McQuiston mine,
187. Rupert mine,
188. Old Alps mine,
189. Coulterville mine,
190. Ciera mine,
191. Scotch Hill mine,
192. Blythe mine,
193. White Ball mine,
194. Shaner mine,
195. Stringtown mine,
196. Charleston mine,
197. Buena Vista mine,
198. Armstrong mine,
199. Brinton mine,

The chief features presented by this group of mines are *1st.* the variability of the roof member, which thins from 6′ 2″ at the *Stone mine* southward to 3′ 9″ at the *Upper Walton mine*, near Elizabeth, and always a worthless mass of slate and coal, poorest where thickest. *2nd.* the greater regularity of the mining portion of the bed, the breast coal averaging 3′ 3″; the bearing-in nearly 4″ and the brick coal about 11″, or a total yield of mining coal of 4′ 6″. The entire output of these mines is highly prized for domestic and steam use and a large proportion is used for the manufacture of illuminating gas in the lower Ohio cities. Plan of Walton mine is shown on plate 518; tipple devices and plans in plate 517.

The outcrop of the coal is everywhere exposed to ready attack through the countless small streams entering the river, so that it may be concluded that this region, despite its somewhat thinner coal section, has furnished an enormous amount of the most cheaply mined and most highly prized coal from the Pittsburgh district.

Still many irregularities,* caused by swamps, spars, clay veins and other troubles this bed is affected by, have had to be overcome, although nearly all the coal is drained and moved favorably toward point of shipment.

On Beams run and Peters creek the Pittsburgh coal crops

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unmined territory is all situated back in third hill about 1¾ miles from river. The south end of first hill tunnel is 1056′ A. T. a fall of 6 along the axis; the south end of second tunnel is at 1043′, or a fall of 19′. Here a surface road crosses a branch of Whiteacre run, entering third tunnel at 1038′ A. T. All these elevations represent the *south-west fall* of the coal and *not* the dip, which is to the south-east.

* Thus a swamp 16′ deep and 300′ wide was met with in *Upper Walton mine* and some of the clay veins fault the coal members to a considerable extent. The Jones mine shows numerous troubles also, but mainly confined to roof members. Upper portion of breast coal bench varies here from 2′ 10 to 3′ 6″.

The *Lower Walton mine workings* show a swamp 19′ deep and 450 wide passing through south side of this mine and west side of Upper mine. Product of the mines yields 70% lump. 17% nut and 13% dust coal. The *Blackburn mine* shows additional interruptions to systematic mining. Two swamp entries drain the coal in second hill into Lewis run. Swamp is irregular in size and shape.

well to the north-west, owing to the effect of the Pin Hook axis, the roof division showing about 2′ 6″, main clay 6″ to 10″ and lower division 5′ 6″.

In the rear workings of *Pine Run mines*, in the Ober's hill, an elliptical swamp 50′ deep and 600′ wide has no apporent drainage outlet. A fault is found along its margin that displaces the coal members about 3′ and numerous swells and horsebacks in the overclay were observed from 1½′ to 3½′ thick and from 2′ to 14′ long. The same story is repeated in many places between here and Peters creek in other works contiguous to the basin line.

Mines in Pool No. 3, Washington County.

This pool extends along the river from Elizabeth to a point about midway between Columbia and Bellevernon. In addition to receiving the coal from a number of operations on the east side of the river (already described earlier in this report) all the coal in the Peters Creek region on the B. & O. R. R. along the river front in Union and Carroll twps. of Washington Co. is made tributary to it (Plates 524, 525 and 526.)

The Pin Hook axis still makes itself felt on Peters creek, passing close to the *Lockhart mine*, where the Pittsburgh coal lies on its arch at 984′ A. T., dipping up and down stream, whilst the Roaring Run axis lies close to the river in north-east Washington Co., passing through the *Hillsdale*

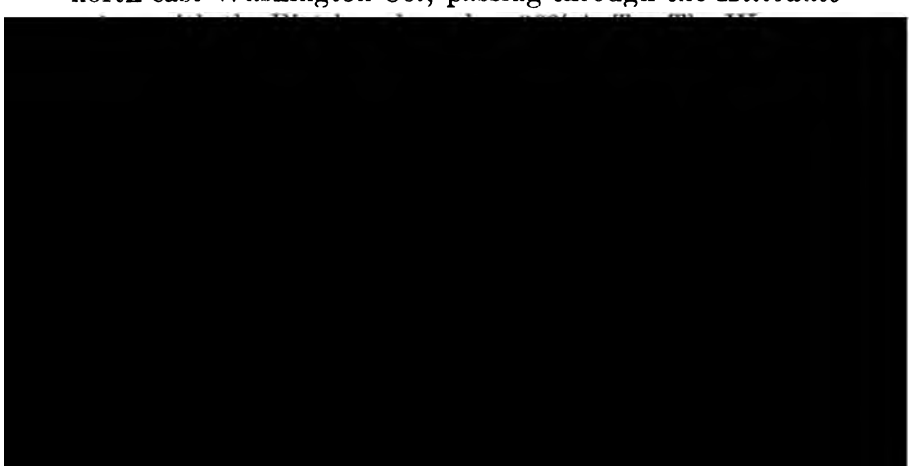
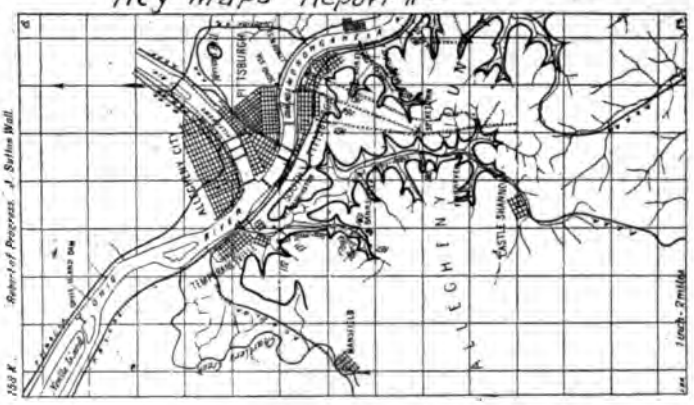


PLATE 520.

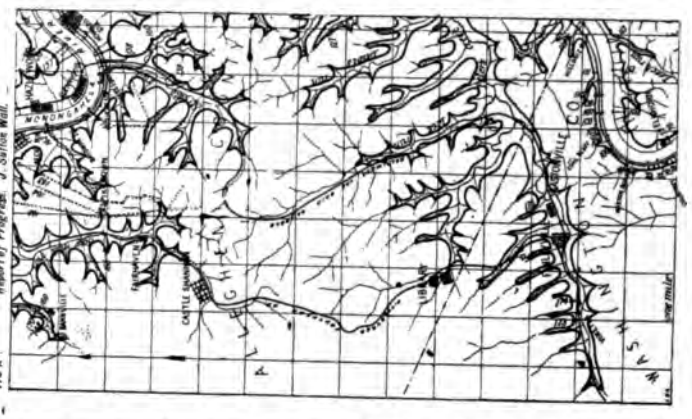
XV. Monongahela mines, Pittsburg bed.

Key Maps Report K4

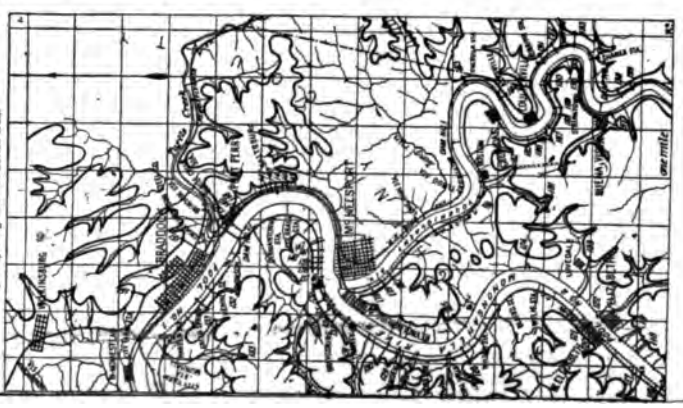
1.



2.



3.



ham twp. line, with the following sections at the principal mines:—

Locality.	Roof Division.	Main Clay.	Lower Division.			
			Breast.	Bearing-in.	Brick.	Bottom.
Venetia, ...	4′ 7″	1′ 0″	3′ 4½″	0′ 3½″	1′ 1′	1′ 4′
Lockhart, . . .	. . . . .	0′ 10″	3′ 6″	0′ 3″	0′ 10″	1′ 3″
Segler, ...	. . . . .	0′ 0″–2′ 0″	3′ 0″	0′ 3″	1′ 0″	1′ 4″
Finleyville, . .	5′ 0″	0′ 10″	3′ 2″	0′ 4″	1′ 2″	1′ 4′

The product of the *Peters Creek** and *Nottingham mines* is carried to the Wheeling and Chicago markets via the B. & O. R. R. and is highly prized for fuel and gas purposes, mining out in large cubical blocks. The bottom bench is everywhere impure. The country hereabouts is largely cut up by ravines, giving rise to a good deal of "red coal" near the outcrop. The *Redstone coal* is 2½′ thick and about 65′ above Pittsburgh bed.

*Mention must be made of the excellent quality of the limestone occurring beneath Pittsburgh coal bed along Peters creek. It shows about 8 thick, buite persistent; quarried at lark's above Finleyville and at covered bridge near Gastonville. Very pure, makes excellent furnace flux and the clay resulting from its decomposition is said to make a serviceable pottery clay. It is dove colored, and without siliceous matter.

Along any of the roads leading from Peters creek over to Mingo creek and the river, sections of the Upper Productive measures are passed over, in places reaching to the Waynesburg "b" coal bed. Thus going south from Currysville the *Waynesburg coal* is found about 250′ above the Pittsburgh bed, and the *Uniontown coal* is also exposed about 2′ thick, resting on the Great Limestone, which everywhere spreads through the hills in this part of the district.

Representative river mines in this pool show as follows in Washington Co:—

Locality.	Roof.	Main.	Lower Division.			
	Division.	Clay.	Breast.	Bearing-in.	Brick.	Lower Bottom.
Black Diamond,	3′ 4″	0′ 10″	3′ 2″	0′ 3″	1′ 1″	1′ 2″
Ivile,	3′ 2″	0′ 10″	3′ 1″	0′ 3½″	1′ 0″	1′ 2″
New Catsburg,	4′ 7″	0′ 10″	2′ 11″	0′ 3″	1′ 3″	1′ 3″
Dry Run,	3′ 10″	0′ 9″	2′ 9″	0′ 3″	1′ 2″	1′ 3″
New Eagle*,	4′ 5½″	1′ 0″	2′ 10½″	0′ 3½″	1′ 1″	1′ 2″
Mingo†,	4′ 10″	0′ 10″	3′ 1½″	0′ 3″	1′ 3″	1′ 0″
Courtney,	3′ 4″	1′ 0″	3′ 0″	0′ 3″	1′ 0″	1′ 3″
Buffalo,	4′ 7″	0′ 10″	2′ 10″	0′ 3″	1′ 3″	1′ 3″
New Coal Bluff,	4′ 0″	0′ 6″–0′ 10″	3′ 3″	0′ 3″	1′ 0″	1′ 2″
Cliff,	3′ 0″–4′ 0″	0′ 8″	2′ 11″	0′ 4″	1′ 1″	1′ 4″
Banner No. 1,	3′ 8″	0′ 10″	2′ 10″	0′ 4″	1′ 0″	1′ 4″
Hindale,	3′ 3″	0′ 8″	3′ 0″	0′ 4″	1′ 2″	1′ 3″

There is comparatively little variation in the mining members of the coal all along the river, providing measurements are made away from swamps, where the whole bed is generally somewhat swollen. In seven of the largest mines given in the table, the total average thickness of the entire seam only varies between 9′ 1″ and 10′ 9″ and mainly in the roof coal. The breast coal is about 3′ 0″; bearing-in 3½′ and brick 1′ 1″, so that the commercial output comes from about 4′ 4½″, or slightly less than the second pool average.

Swamps‡ abound however, especially in the two sub-di-

*In *New Eagle mine* the floor is very undulating and in addition to numerous rolls, producing swamps and hills, a fault passes through east side

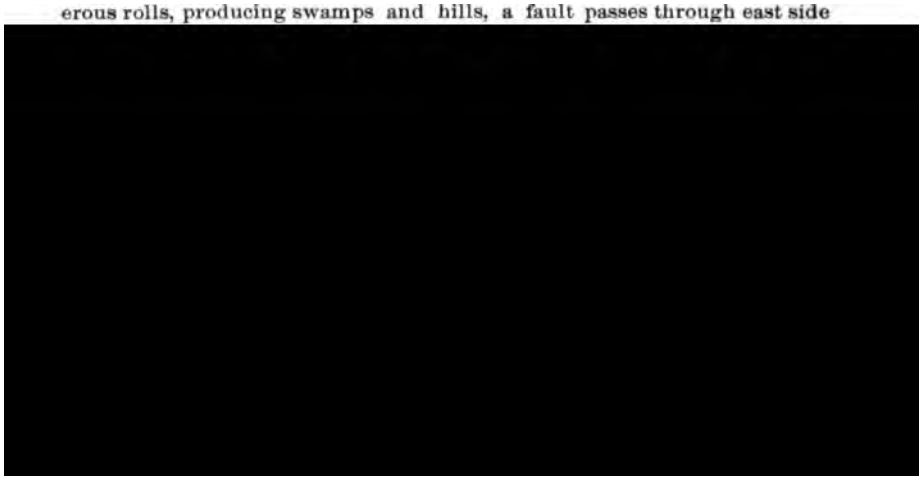
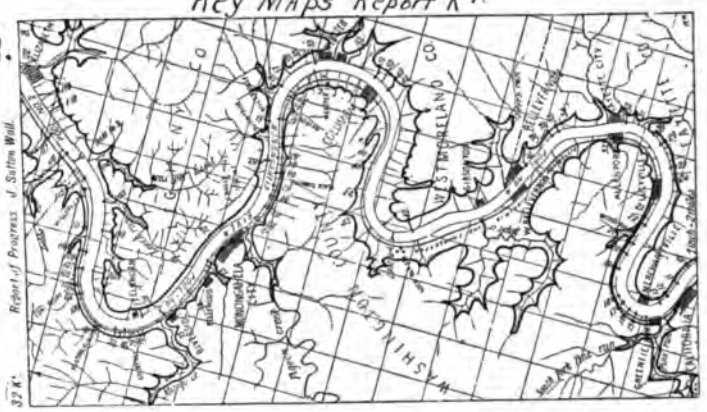


PLATE 521.

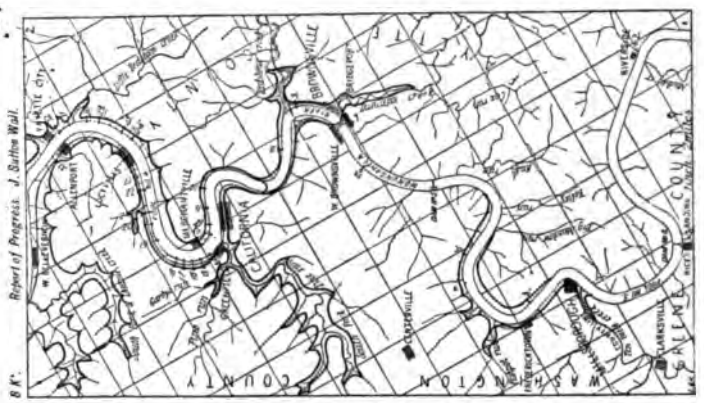
XV. Monongahela mines, Pittsburg bed.

Key Maps Report K⁴.

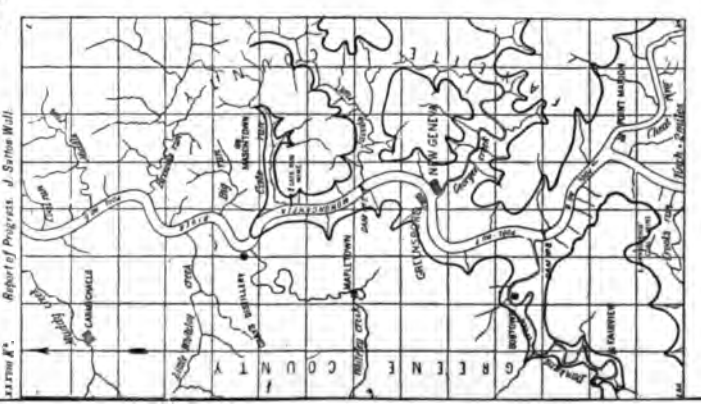
4.



5.



6.



visions of the *Waynesburg basin*, permitting the general statement that these troughs are rarely regular and are commonly marked by irregularities of dip and structure. The coal is everywhere good and always acceptable, yielding perhaps 66% lump, 17% slack and 17% dust; but it grows softer going up the river and shows a tendency to break out into smaller sizes and to yield a fair coke.

The *Upper Productive coal measures* are the surface rocks through seven-eights of the district, a small patch of the *Upper Barrens* resting on the Fallowfield line east of Pigeon creek. On this ridge the *Waynesburg coal* has been opened in the past, reported 4′ thick, capped with the Waynesburg sandstone. On the summit the *Washington coal* is reached, 140′ higher. The *Uniontown coal* can hardly be recognized in the township and it must be very thin. Vertical sections of the Monongahela river series along the river in Greene, Washington and Fayette counties are given on plate 527 and comparative sections with West Virginia exposures in plate 528.

In *Scott's hollow*, running up from Pigeon creek, the lower division of the Great Limestone is present at 55′ above the *Redstone coal*, which is mined by Mr. Isaac Teeple, where it shows two benches 18″ and 21″ thick. The coal here is clean and in good shape, and has a good reputation for domestic purposes. The Redstone coal 3′ to 4′ thick is likewise opened a mile below Lock No. 4.

Just above the *Black Diamond mine*, a stream enters the river from the south, upon which, half a mile from its mouth, the Redstone coal is opened in several places. The coal varies from 3′ to 3′ 6″ thick, and is clean and of good quality. The same coal appears in several other places through the township; is usually 40′ to 50′ above the Pittsburgh coal, and from 2′ to 3½′ thick. Near the mouth of

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where recognized as such under the name of "*swamps*", and are certainly fertile causes of trouble, it seems, in this particular locality, that to the rapid subsidence of the powerful Murraysville axis should be charged much of the widespread differences of level co-incident upon the blending together of the several sub-synclinals, elsewhere held apart by the presence of that axis. The structure of this immediate region is unique in the district.

Mingo creek, it shows an unusual development, being reported there, in an old air shaft, 4′ thick, overlaid by 10″ of clay, and this in turn by 2′ of coal and shale.

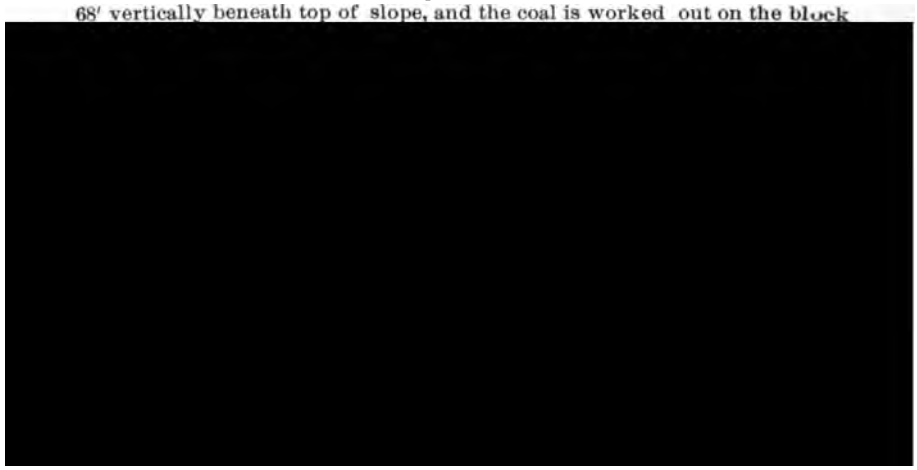
Mines in Pool No. 4, Washington County.

The fourth pool extends from Lock No. 4 below Bellevernon to Lock No. 5 above Brownsville and Bridgeport. All the coal mined in this area lies to the east of the Waynesburg axis, in the *Lisbon* (Irwin) *basin*, and it also shows a marked change in character and section in this pool as compared with the region north-west of the axis.

The principal *Washington Co. mines* are given in the following table, those in Fayette Co. and along the Redstone having been already described:—(See plate 526).

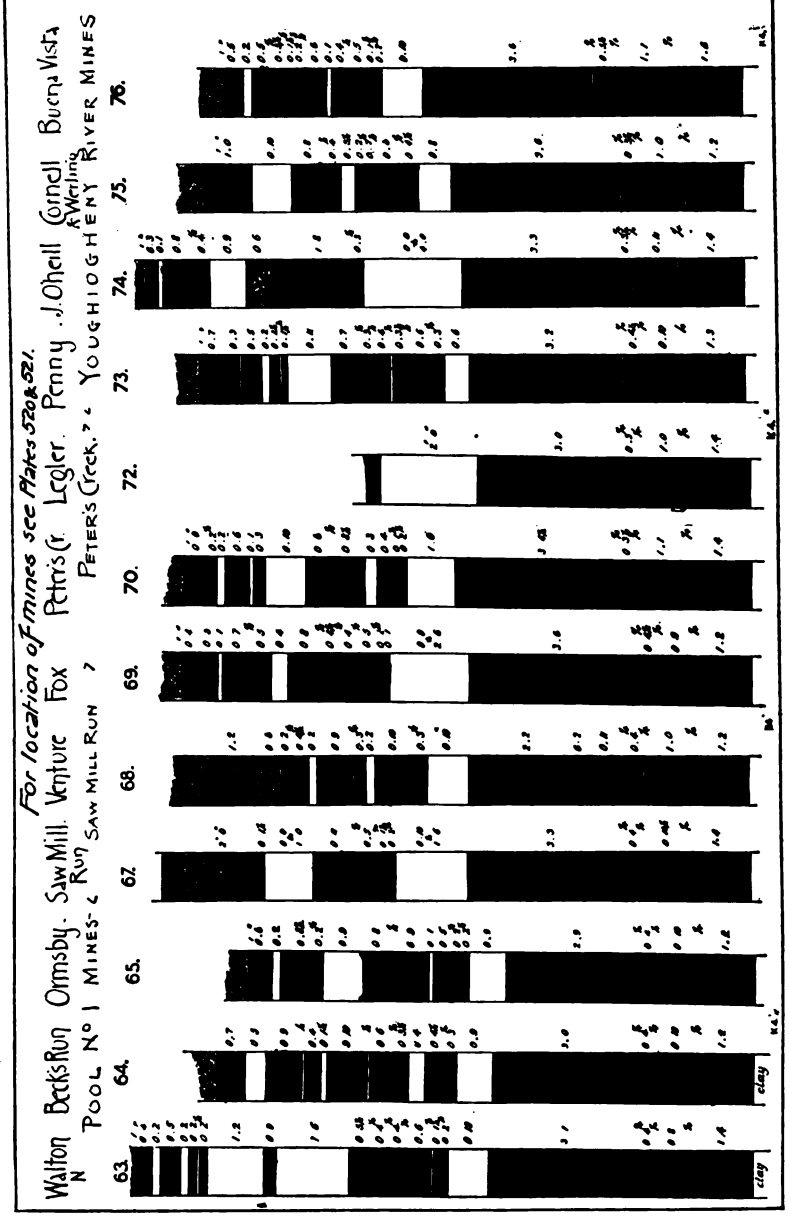
Locality.	Roof Division.	Main Clay.	Lower Division.			
			Breast.	Bearing-in.	Brick.	Lower Bottom.
Knob mine,* . . .	0′ 6″	1′ 0″	5′ 9″–6′ 0″	0′ 3″	1′ 2″	1′ 9″
Caledonia,† . . .	0′ 10″	0′ 10″	5′ 8″	0′ 3″	1′ 4″	1′ 10″
Champion,‡ . . .	4′ 1″	1′ 0″	4′ 9″	0′ 2″	1′ 4″	1′ 6″
Woods Run, . . .	0′ 10″	0′ 10″	5′ 0″	0′ 3″	1′ 3″	1′ 4″
Clipper,§	3′ 5″	0′ 10″	4′ 9″	0′ 2″	1′ 1′	1′ 4″

* *Knob mine* slopes for Pittsburgh coal which is 34′ below low water and 68′ vertically beneath top of slope, and the coal is worked out on the block



XV. Pittsburgh bed. Monongahela river.

No. 1 - Sections from Report K4.



In this field the variability, but usual thinness, of the roof members will be remarked, accompanied by the rapid thickening up of the lower division, so that sometimes the entire seam is mined, whilst frequently 7½′ of good coal is won. Though not regarded so valuable for shipping as the coal from the lower pools, on account of being more tender and friable, it is rapidly coming into favor as a coking coal, over a thousand tons daily being taken from the *Jones and Laughlin mines* near Fayette City by boat to their Pittsburgh ovens. The increased thickness of the bed; its favorable condition for mining; its value as a metallurgical and steam fuel and the cheapness with which it can be mined, all point to an enormous future growth of this *Upper Monongahela district* well into West Virginia.* Moreover the developments so far made indicate a greater regularity in the coal bed than lower down the river; but it must be remembered that mining has been largely confined to the east flank of the Waynesburg axis.

The *Upper Productive Measures*, above the Pittsburgh coal, spread over a wide area in Fallowfield, Somerset, Allen, East and West Pike Run and East Bethlehem twps. tributary to the fourth pool.

The *Waynesburg coal*,† at the top of the series, is ex-

*The old prejudice against the coal in these upper pools is rapidly disappearing under the excellent results which have attended its increased production and use in the past decade, and no doubt the next 10 years will witness a development of this area hardly credited a few years ago.

†At *Grables bank* it shows three benches, and the same on the south fork of Saw Mill run as follows:

		1	*2.*
Waynesburg Coal bed	*Coal*, upper bench,	0′ 11″ and	1′ 0″
	Clay,	1′ 2″ "	1′ 3″
	Coal	2′ 10″ "	2′ 8″
	Parting	?	?
	Coal	1′ 1″	1′ 0″

At *Opening No. 1* (Warner) the bed is capped with 3′ of bluish shales, containing great numbers of plant impressions. The top coal bench is poor and slaty; middle bench good, but sulphurous; bottom bench, impure. The Great Limestone is rather shaly along Saw Mill run. The interval be-

posed at many localities in Fallowfield twp., though generally neglected on account of the superiority and accessibility of the Pittsburgh coal.

West of Pigeon creek it is more favored. In Somerset twp. only 150′ of measures below the Waynesburg coal are exposed. The *Waynesburg coal* at Bentleysville (No. 1) and at Richardson's, 3 miles east (No. 2) shows the following measurements:

	1.	*2.*	
Coal	0′ 10″	0′ 11″;	worthless, and not mined.
Clay	1′ 2″	1′ 1″	
Coal	2′ 8″	2′ 6″;	good coal, clean; bulky ash.
Clay	0′ 2″	0′ 3″	
Coal	1′ 1″	1′ 3″;	pyritous and slaty.

Other variations in this coal bed in this township, where it is largely mined on account of the Pittsburgh coal being buried, are given below in tabulated form:

Waynesburg Coal Bed; Somerset twp: Washington Co.*

Locality.	Upper Bench.	Clay.	Middle Bench.	Parting.	Lower Bottom.
1. Scott,	0′ 2″ – 0′ 4″	1′ 2″	3′ 0″	0′ 0½″	0′ 7″
2. Shaner,	1′ 2″	1′ 2″	1′ 10	0′ 2″	1′ 6″
3. J. Huffman,	0′ 10″	1′ 3″	3′ 0″	0′ 0½″	1′ 0″
4. J. J. Huffman,	1′ 0″	1′ 0″	3′ 4″	0′ 1″	0′ 6″
5. Burgen,	1′ 0″	1′ 3″	3′ 6″	0′ 2″	2′ 2″
6. Hethenington,	0′ 11″	1′ 1″	2′ 7″	0′ 2″	1′ 2″
7. Meyers,	1′ 3″	1 2″	2′ 10″	0′ 5″	1′ 4″
8. Couch,	1′ 2″	1′ 0″	2′ 10″	0′ 6″	1′ 3″
9. Emery,	0′ 10″	1′ 2″	2′ 8″	0′ 8″	1′ 4″

[redacted]

XV. Pittsburgh bed: mine sections, contin?

No. 2. Monongahela River Series Report K4.

burg coal shows 3′ 6″ in Kreps Knob; the Waynesburg sandstone 30′; the Uniontown coal 3′. At the head of Lilly's run the *Waynesburg coal* is double; coal 10″, clay 3″ and coal 2′ 6″, and somewhat sulphurous. Below Greenfield the Great Limestone shows two divisions of 10′ and 85′, and the Redstone coal merely 1′ of shale 25′ above the Pittsburgh coal.

In *West Pike Run twp.* the entire group is above water level, but poorly exposed; but four sections of the *Waynesburg coal* show:

	J. Hill.	S. W. Rogers.	C. Sellers.	J. M. Miller.
Coal,	1′ 0″	1′ 0″	0′ 9″	0′ 10″
Clay,	1′ 1″	1′ 1″	1′ 0″	1′ 0″
Coal,	3′ 0″	2′ 8″	2′ 4″	2′ 3″
Clay,	0′ 2″	0′ 1½″	0′ 2″	0′ 4″
"*Brick*" *coal*,	0′ 3″	0′ 3″	0′ 3′	0′ 3″
Clay,	0′ 2″	. . . . .	0′ 1″	. . . . .
Coal,	1′ 6″	1 5″	1′ 3″	1′ 4″

Mines in Pool No. 5, Washington and Greene Counties.

This pool extends from a little above Brownsville to Lock No. 6 at Rice's Landing, 2 miles above the mouth of Ten Mile creek and the Greene Co. line.*

The principal openings on the west side of the river are all small and furnish a limited annual output and are as follows: *Black Hawk*, *Watkins*, *Maple Glen*, *Crouch*,†

*Some additional new openings may have been made for shipping coal from this part of the district since the Ann. Rep. of 1886 was prepared; but this region is still without railroad communication, and shows such a limited outcrop of the Pittsburgh coal, wholly confined to the river for about 4 miles below Ten Mile creek, that comparatively little attention has been given to it.

† *Crouch's pit* lies just beyond a small ravine, ¼ mile above Maple Glen. Bottom of bed is not well exposed but it is in all about 8′ thick. Roof coal shows about 10″; main clay 1′; and then 46″ to a small parting, beneath which there is 38″ exposed.

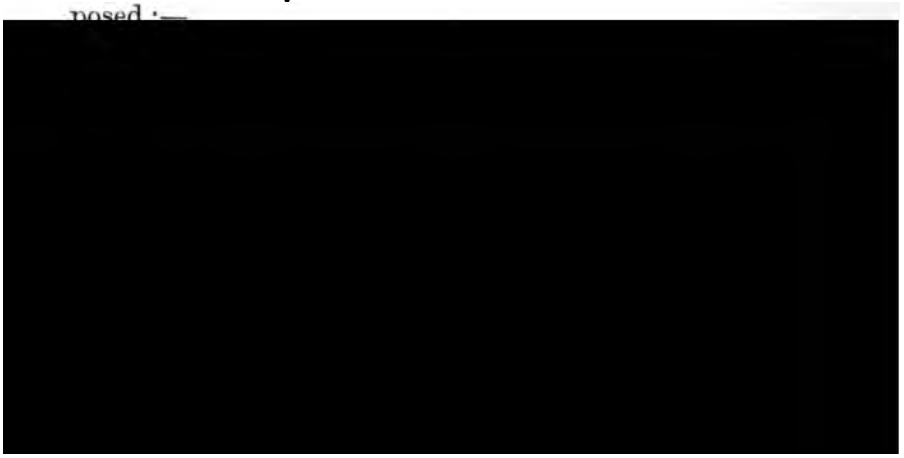
Register,* *Phillips* and *Montgomery*. The only opening on the east side is the *Evans pit*,; the coal dipping everywhere south-east, away from the Waynesburg axis, which is only 1½ miles east of Fredericktown, near the principal seat of development.

The *Black Hawk mine* (plate 526 fig. 1) furnishes a typical section for this region, showing a carbonaceous shale roof of 2′; roof division coal 1′ 0″; main clay 1′ 0″; breast coal 4′ 6″; bearing-in coal 2″ and brick and bottom coal 2′ 6″. The commercial coal mined averages about 6½′, leaving 2½ of coal in the bottom for better drainage, as the pit is only 15′ above the river. At the *Maple Glen mine* the coal was considerably squeezed by a massive sandstone roof.†

The *Vandegrift pit* shows roof coal of 10″; main clay 1′ 0″; breast coal 3′ 8″; bearing-in coal 0′ 4″ and brick and bottom 3′ 4″.

Back of Fredericktown the lower division is 6′ 6″ thick. The crop extends through the rear part of Millsboro and half a mile up Ten Mile creek. At the *Montgomery pit*, where the coal sinks beneath the river, the roof coal is 6″; main clay is 6″ and 6′ of lower division. The coal does not appear in the river again until after the *Lisbon basin* is crossed at Muddy run, as far south as Grays Distillery, above Whiteley creek.

In the high hill above the mouth of Dog hollow, the following section of the *Upper Productive Measures* is exposed:—



XV. Pittsburgh coal bed, Mine Sections

No. 3. Monongahela River Series. Report K4

Waynesburg sandstone,	35′
*Waynesburg coal bed,**	5 8′
Concealed,	125′
Sandstone,	10′
Limestone,	80′
Shale,	5′
Sewickley coal bed,†	2′
Sandstone,	40′
Limestone,	25′
Sandstone and shale,	25′
Redstone coal bed,‡	blossom.
Sandstone,	50′
Pittsburgh coal bed,	7′
Concealed,	12′

Two miles below Fishpot run both the *Redstone* and *Sewickley* beds are seen at intervals of 40′ and 130′ above the Pittsburgh, and between the beds a mass of limestone 25′ thick. A mile further down, on land of Elias Crouch, the same beds are exposed, with the Great Limestone showing on top 65′ thick.

At Lock No. 5, a similar section shows, the Sewickley coal 3′ thick. It is again exposed, 1 mile from Brownsville, at Henry Howard's residence, in two benches 3′ 6″ and 0′ 8″ thick, separated by 2′ of shale, all capped with the Great Limestone on the National Pike. The *Waynesburg coal*

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*The *Waynesburgh coal* is very poor, containing a good deal of sulphur and leaving much ash and cinder. Between school houses 7 and 8, openings were seen belonging to *Messrs. Henry Brister* (1) *A. Broswer* (2) *E. Buchingham* (3) and *N Barnard* (4), which gave the following measurments:—

Waynesburg coal bed	*1.*	*2.*	*3.*	*4.*
Shale,	0′ 0″	1′ 2″	0′ 2″	0′ 0″
Coal,	0′ 5′	0′ 8″	0′ 9″	0′ 5″
Clay,	0′ 3′	0′ 5¼′	0′ 8″	0′ 6″
Coal,	1′ 4″	1′ 3″	1′ 4″	1′ 6″
Clay,	1′ 0″	0′ 11″	1′ 2″	1′ 4″
Coal,	1′ 6″	1′ 8″	2′ 5″	2′ 0″
Clay,	0′ 0½″	0′ 0′½	0′ 5″	0′ 5″
Coal,	0′ 8″	0′ 10″	. .	0′ 3″

†At Clarksville the Sewickley coal is 15′ above creek and the Great Limestone extends up to hill top in several layers of limestone interstratified with shale and sandstone.

‡Along river at Millsborough, the Redstone coal shows 1′ thick at about 45′ over Pittsburgh seam, and mostly shale. At Fredericktown the bed yields about 6″ of coal in a mass of bituminous shale 6′ thick.

shows just beyond Centreville, and was formerly opened on the properties of Messrs. Horton & Welsh.

One other exposure of the Upper Productive measures—hardly to be considered by reason of its inaccessibility at present—occurs at the village of Pin Hook or Pleasantville, in Amwell twp. Here the top members of the group are brought up on the crest of the Pin Hook axis, and the following measurements of the *Waynesburg coal*, largely opened there, shows:—

Waynesburg coal.	1.	2.	3.	4.	5.	6.	7.
Coal, ...	1′ 1″	0′ 2″–0′ 9″	1′ 4″–0′ 11″	1′ 0″	1′ 0″	0′ 4″–0′ 5″	1′ 0′
Clay, ...	1′ 0″	1′ 2″	1′ 6″–0′ 10′	1′ 0″	1′ 0″	1′ 2″–0′ 10″	1′ 0′
Coal, ...	3′ 0″	2 10″	2′ 7″–3′ 4″	3′ 2″	3 3″	2′ 10″	2′ 8′
Clay, ...	0′ 6″	0′ 6″	0′ 2½″	0′ 3″	0 3″	?	?
Coal, ...	. . .	0′ 6″	0′ 5″	0′ 7″	0′ 6″	0′ 6″	

Mines in Pool No. 6 in Greene County.

This long pool extends from Rice's Landing to within 2 miles of New Geneva. The river keeps a pretty straight south-east course cutting across the *Lisbon basin*, whose central line is marked by a sub-basin anticlinal roll at the mouth of Muddy creek, dividing the basin into two divisions.

Only two openings, the *Jacob's Slope** and *Cat's Run* mine, have been made on the Pittsburgh coal in this basin.

XV. Pittsburgh bed on the Monongahela.

No 4. Rep. K4 Monongahela River Series.

For location of mines see Plates 520 & 521

MINES IN POOL No 3

Gilmore | Milesville | Rankin | Black Diamond | Ivile | New Gatsburg | Dry Run | New Eagle | Mingo 1 | Mingo 2 | Old Eagle | Courtney No 1 | Courtney No 2

17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29.

creek; up Muddy creek for 4 miles and up Whiteley creek for a distance of 8 miles from the river. The series varies from 458′ to 487′ in thickness.

The *Waynesburg coal* attains its greatest development in Greene Co. and forms the chief source of a fuel supply in the absence of the Pittsburgh coal. Lying 400′ above the Pittsburgh coal it naturally has a very much wider outcrop and it is more often accessible; but its thickness is very variable. It contains about 50% fixed carbon; from 32 to 36% volatile matter; 1.3 to 3% sulphur and 11 to 13.5% ash. (Vertical Sections on plates 479 and 480).

Its bed section and character can be best shown in the following table:—*

Number.	Coal.	Clay.	Coal.	Clay.	Coal.
1, ...	1′ 6″	1′ 5″	3′ 0″	. . . . .	. . . . .
2, ...	1′ 3″	0′ 3″	2′ 0″	1′ 3″	3′ 2′
3, ...	1′ 7″	1′ 7′	2′ 8″	. . . . .	. . . . .
4, ...	1′ 0″	0′ 5″	1′ 3′	1′ 2″	2′ 6′.
5, ...	0′ 8″-1′ 3″	0′ 2″-0′ 6″	1′ 7″-2′ 0″	0′ 6″-2′ 2″	2′ 3″-2′ 11″
6, ...	1′ 1″	0′ 1″	1′ 6″-1′ 10″	1′ 9′	2′ 9″
7, ...	1′ 10″	0′ 1″	2′ 1″	0′ 1″-0′ 10″	3′ 0″
8, ...	1′ 2″	0′ 2″	2′ 0″	1′ 0″	2′ 6″
9, ...	0′ 8″-1′ 0″	0′ 1″	1′ 11″-2′ 2″	0′ 8″-1′ 0″	2′ 9″-3′ 2′
10, ...	0′ 6″	0′ 2″	2′ 2″	0′ 2″	1′ 11″

1. Bollenfield's School, Ten Mile creek. 2. Jefferson. 3. Jesse Bell. 4. Clarksville. 5. Rex's opening near Jefferson. 6. G. W. Connor in Cumberland twp. 7. Ceylon. 8. McClary's on the river. 9. Little Whiteley creek. 10. Big Whiteley creek.

*No set of sections can fully show the variations this bed is subject to. For instance in many places it is merely a double bed, consisting of two coal benches parted by a thick slate; at others, such as at Hewston's property near Carmichaels on Muddy run it shows a much more complex structure, with coal benches of 1′ 0″, 1′ 9″, 2′ 2″, 0′ 3″ and 0′ 5″ and partings of 0′ 2″, 0′ 2″–0′ 10″, 3′ 0″ and 0′ 4″. It is generally an inferior coal; some of it furnishing a fair free burning fuel, but the bulk of it pyritous and slaty. At all exposures in Jefferson twp. the coal is inferior, the principal point of mining being along Ten Mile creek. At Ceylon in Cumberland twp., the bed furnishes its maximum of coal and is well spoken of, and it shows an improved character on Glade run east of Carmichaels, where it varies between 6 and 7′ and always shows three benches, divided by a thick and thin parting.

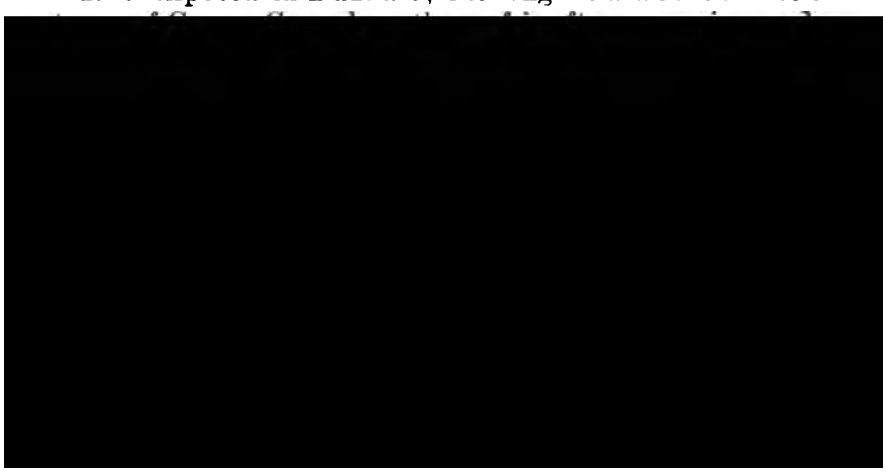
The *Uniontown coal**, about 90′ lower in the series, is a very persistent horizon, though always worthless for fuel.

The *Sewickley coal* attains considerable size and importance along Whiteley creek, where it lies 110′ above the Pittsburgh coal and is mined 4′ 7″ to 5′ 6″ thick, though only locally developed. At Gray's Landing it is 70′ above the river and shows coal 2′; cannel shale 1′; coal 2′ 0″; total 5′ 0″.

It is well exposed on Whiteley creek up to Mapletown, and at numerous openings at Hartley's mill it shows a very different section as follows:—coal, top bench, 8″; clay 0¼″; coal 0′ 2″ to 0′ 7½″; clay 0½″; coal 1′ 10″; clay 1″; coal 1″ to 7½″; clay 2″, coal 1′ 1″. The top and bottom benches yield fair coal, but the middle benches contain much sulphur, though less ash than the Waynesburg bed. At Mapletown it shows three coal benches, 2′ 3″, 0′ 4″ and 2′ 6″, parted by clay bands of 1″ and 2″.

The *Redstone coal* in Greene Co. lies about 60′ above the Pittsburgh. Though persistent, it is very variable in size and quality. Here it contains, along the Monongahela, a larger amount of shale than coal, the former at Greensboro' being 13′ thick and the coal only 18″. It varies rapidly. The Pittsburgh sandstone separates this worthless coal from the magnificent Pittsburgh bed which is splendidly developed along the river in Greene Co , though as yet only available for country use, with rare exceptions.

It is exposed in Dunkard, Monongahela and Jefferson



XV. Pittsburgh Coal-bed, Monong. river.

No. 5. Sections from Report K4. Monongahela River Series.

–10½ miles. The Pittsburgh coal is everywhere accessible though rising higher and higher in the hills going southwards towards the Fayette axis; but in Greene Co. there is a good area of drift coal in Monongahela and Dunkard twps., while shallow shafts on Whiteley and Dunkard creeks, beyond its outcrop, will serve to develop a large additional area of very thick and good coal.

In *southern Greene Co.*, near the State line, the Pittsburgh coal* at the *Van Voorhees pit* measures 7′, with only one half inch slate 6′ above the floor. Near Bobtown on Dunkard creek the seam is 11′ thick, with one thin clay parting 8′ above floor; while on the Fayette side the main coal member yields 8′ 6″; main clay parting 0′ 2″ to 0′ 8″ and roof coal 2′ 0″ to 4′ 0″.

At *Black's bank* at Greensboro the roof and main clay each shows 1′ thick; the lower division 9′ thick, with benches of 6′, 1′ 0″ and 2′ 0″, the partings hardly perceptible. At *Dillner's pit*, at a small patch opposite the mouth of Cheat river, the roof coal is 0′ 4″; main clay 0′ 1″ and lower division 5′ 2″; but this is an unusual degradation of the seam, for at Crow's Ferry, 1½ miles down the river, it is 9′ 7″ thick as follows:—coal 6″; clay 3″; coal 8″; clay 1′ 2′ and coal 7′ 0″.

Along Dunkard creek the crop crosses the State road and from there to its disappearance above Fairview, it closely hugs the stream, conspicuously roofed by a massive sandstone.

At *Hickman* and *Sullivan's pits* near Fairview, coal is left in the floor and wagons are driven directly into the bank for loading, the bed showing roof coal 0′ 4″; clay slate 0′ 1″; breast coal 5′ 7″; bearing-in coal 3″ and bottom coal mined 9″.

The *Waynesburg coal* near Fairview is 370′ above the Pittsburgh coa land at *W. McClure's* shows four benches, in

*The Pittsburgh bed is opened to the east of the State road at Van Voorhis, Brown, Miller and Titus around to the Greensboro–Wiley P. O. road. The bed varies from 7′ at Millers to 8′ 4″ at Zion church, and to 10′ 2″ at Titus' bank facing Dunkard creek.

all 8′ 2″ thick, but yielding, poor variable and slaty coal. On Crooked run it shows everywhere 7′ to 8′ thick, but always variable, impure coal, cut up with numerous clay partings.

On the river road from Greensboro' to Mapletown, the *Sewickley coal* is mined and opened at several places. It varies from 5′ to 5′ 6″ thick, and is considered to have less sulphur and to be more open burning than the Pittsburgh coal. The *Redstone coal* is everywhere a thin seam with a thick mass of bituminous shale above and below. It is about 30′ above the Pittsburgh coal, and only 45′ beneath the Sewickley. In Dunkard twp., only three miles, distant, the same intervals are 50′ and 60′.

Near the Centre school house, south of Fairview, the *Sewickley coal* is exposed at 975′ A. T., showing about 5′ thick, with two small partings and 3″ of bony coal on top. The same bed is opened about half a mile above Fairview on Dunkard creek, by Mr. S. Everly, 100′ above the creek and about 5′ thick. It here shows only two divisions 2′ and 3′ thick separated by 1″ of clay slate. It is at water level at the mouth of Meadow run, and mined there by J. Debolt.

On Crooked run, 4 miles from the river, the same bed shows two benches at John's pit, 2′ 4″ and 3′ 0″ thick.

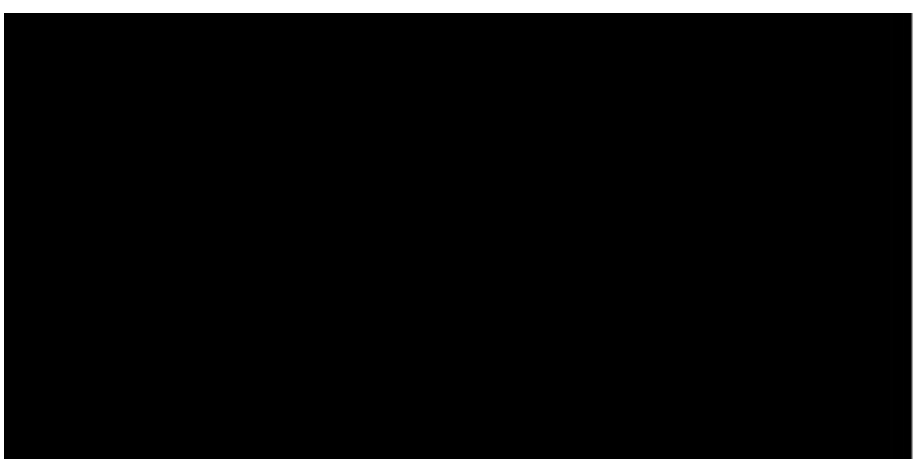
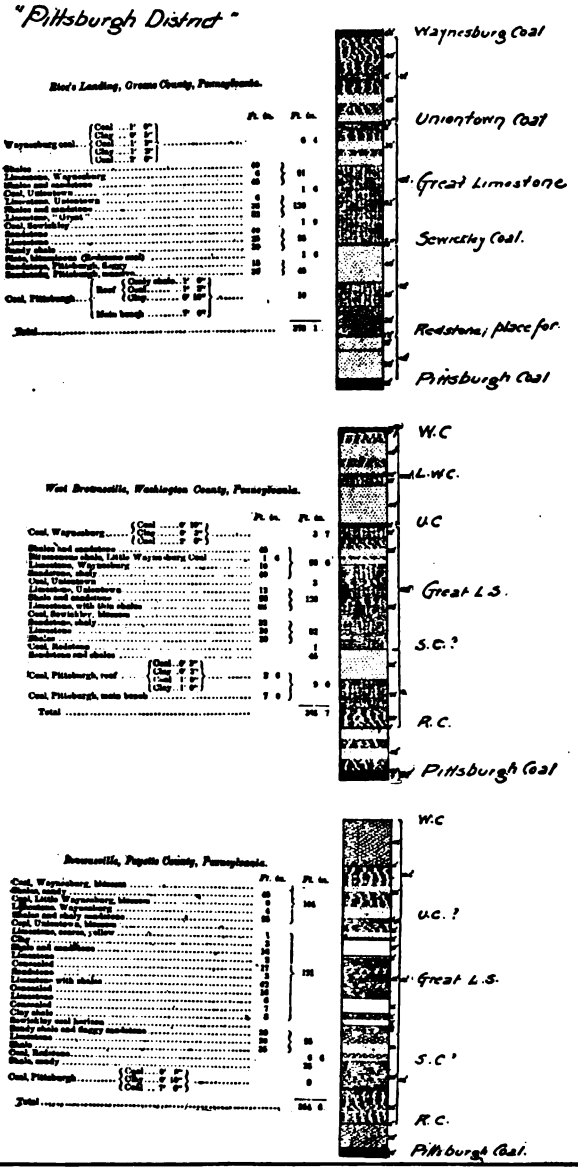


PLATE 527.

No XV Upper Productive or Monongahela River Series

Vertical Sections along the upper Monongahela.

"Pittsburgh District"



CHAPTER CXXVII.

No. XVI. Upper Barren Measure Series.

The *Upper Barren Measures No. XVI* are the highest measures left uneroded in south-western Pennsylvania. Their outspread west of the Monongahela river is confined to Greene and Washington Cos. south of the Panhandle R. R., one small patch capping a high hill along the Allegheny–Washington Co. line between the Chartiers Valley R. R. and the Wheeling Division of the B. & O. R. R.

East of the Monongahela river they are not preserved in any of the basins east of Chestnut ridge, nor can they be found north of the Penna. R. R. in Westmoreland Co.

About ten detached and small areas of these rocks mark the central line of the *Blairsville* (Connellsville) *basin* in its deepest portion, between Latrobe and Uniontown.

They are entirely eroded from the *Greensburg basin* next west, and in the *Lisbon* (Irwin) *basin* are likewise confined to the centre of the trough, five small areas showing in Westmoreland Co. south of Irwin; three more in Fayette between the Youghiogheny and Redstone creek, and a more compact, larger area south of the latter stream, almost equally divided by Dunlaps creek, below the Redstone and the Monongahela. Vertical sections of these measures are shown on plates 529 and 530.

They are variously referred to as the *Permo-Carboniferous* * and *Dunkard Creek Series*, but have usually been

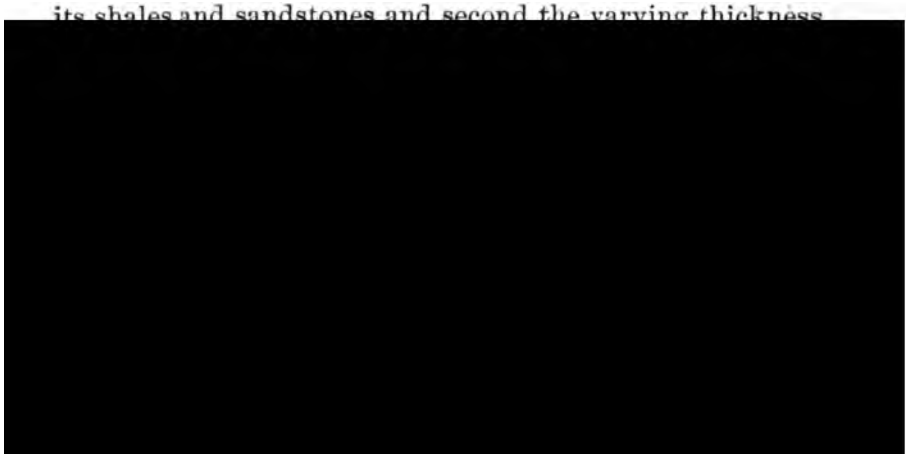
*The highest pile of coal measures has been preserved in Greene Co., near the State line, where the upland summits have an elevation of 2000′ above tide, and the bottom of the great conglomerate No. XII has settled down to a depth of more than 500′ below tide. Plants strongly resembling those fossilized in the *Permian strata* of Europe have been collected from the upper rocks in Greene Co. and the neighboring district of West Virginia by Profs. Fontaine and White, and extensively illustrated in Report PP 1880.

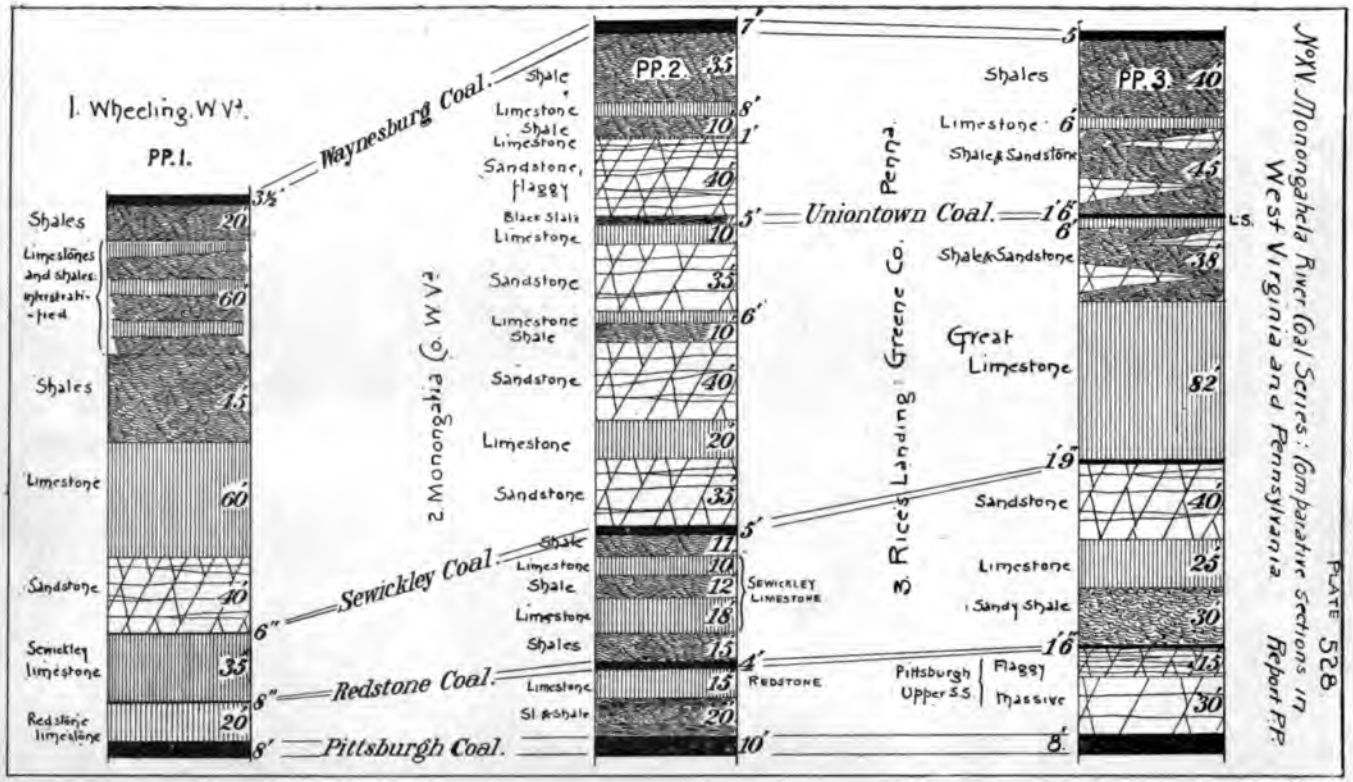
divided in Pennsylvania into two series; an upper *Greene Co. group*, and a lower *Washington Co. group*. Their combined thickness is about 1000′, the upper having an extreme thickness of 800′ and the lower about 500′ in Greene Co. but only 150′ in northern Washington. They consist of gray and red shales, sandstones, numerous limestones and a number of thin coal beds, one or two of which are locally workable.

In the *Greene Co. group** there are only two coal beds which can be mined for local use, the *Nineveh* and *Dunkard beds* both thin and variable, but extending widely through the district. So too are the limestones and sandstones; so that vertical sections of these measures vary in every township. There is however one limestone of great size, underlying large region of country, called the *Upper Washington limestone No VI*, weathering to a snowy whitness, which has been used as the key to the geology and the base of the Greene Co. group, or rather the top of the Washington Co. series. It is the *Sixth limestone* of the series above the Waynesburg lower coal bed.

The *Washington group* below holds five more thin coal beds and five more thin limestones. The lowest beds of the groups are preserved to the edge of the Monongahela valley and to the Beaver and Allegheny Co. lines to the north.

Were it not for the limestone numbers of the series, and two of its coal beds, the order of its rocks would be difficult to make out; first because of the varying character of its shales and sandstones and second the varying thickness




No. V. Monongahela River Coal Series: Comparative sections in West Virginia and Pennsylvania. Report PP.
PLATE 528
1. Wheeling, W. Va.
PP. 1.
Shales 20
Limestones and shales, interstratified 60
Shales 15
Limestone 60
Sandstone 40
Sewickley limestone 35
Redstone limestone 20
3½'
Waynesburg Coal.
6"
Sewickley Coal.
8"
Redstone Coal.
8'
Pittsburgh Coal.
2. Monongalia Co. W. Va.
Shale
Limestone
Shale
Limestone
Sandstone, Flaggy
Black Slate
Limestone
Sandstone
Limestone
Shale
Sandstone
Limestone
Sandstone
Shale
Limestone
Shale
Limestone
Shales
Limestone
Sl. & Shale
PP. 2.
35
10
40
10
35
10
40
20
33
11
10
12
18
15
15
20
7'
8'
1'
5'
6'
5'
4'
10'
3. Rices Landing Greene Co. Penna.
Shales
Limestone
Shale & Sandstone
Uniontown Coal.
Great Limestone
Sandstone
Limestone
Sandy Shale
Sewickley Limestone
Redstone
Pittsburgh Upper S.S.
Flaggy
Massive
PP. 3.
40
6'
45
16"
L.S.
6'
38
82
19"
40
25
30
16"
15
30
5'
4'
8'

Lithologically considered, the characteristic features of the entire *Upper Barren Series* are:

1st. The absence of workable coal beds. *2nd.* The presence of no less than seventeen limestone beds, the most persistent one of which, the *Washington upper limestone*, 30′ more or less thick, forms the division line between the two groups. *3rd.* The number but great variability in thickness and character of the sandstone deposits, the most characteristic of which is perhaps the *Waynesburg sandstone* at the base, making fine cliffs along the Monongahela river, weathering to honey-combed surfaces and full of crevices and often underlaid by a conspicuous plant bed already referred to.* *4th.* The occurrence of red shale, 80′ thick, near their top in Greene Co., still more prominent in Virginia and suggestive of the Permian strata.

The coal beds germane to the entire series, from below upwards are: The *Waynesburg "A" coal;* the *Little Washington* and *Washington coals;* The *Jollytown*, *Dunkard* and *Nineveh seams.* Though the majority of them are thin and worthless, the two Washington coals near the base are frequently quite valuable coal beds.

A number of sandstone deposits characterize the Upper Barren measures, the highest of which, near the top is is 50′ thick; another, somewhat lower down, 60′ thick, holds the thin Nineveh coal; and a third, called the Fish Creek sandstone, immediately underneath the last, is 100′ thick. In the Washington group a sandstone deposit, 80′ thick, contains in its middle the thin Jollytown coal bed; and at the bottom of the group is a sandstone 30′ thick. These sandstones mark the topography of the country strongly in different localities, but they cannot be used as good guides to the structure on account of the rapid local changes to which they are subject. The palaeontology of the group has, as yet, been little studied.†

*The roof of the Waynesburg coal bed is locally known as the *Muddy Creek plant bed* from its typical exposures in Greene Co.

†The uppermost (14th) limestone contains oacasional fish scales. The 10th. limestone breccia has a shale roof with plants and occasional fish-

In the *Fayette and Westmoreland district*, owing to the shallowing of the synclinal northward, the *Upper Barren Measure Series* are poorly represented. The upper or *Greene Co. group* is entirely wanting and the *Washington Co. group* is shown only at rare localities. In the Blairsville basin only the lowest rocks of the series occur and even they are usually concealed.

The *Waynesburg "a" coal* horizon is reached in Mt. Pleasant twp. of Westmoreland, and in Bullskin, Dunbar and N. Union of Fayette, but nowhere measurable. In the Lisbon trough the upper Washington limestone has been doubtfully recognized in Rostraver twp. of Westmoreland, in Sheplar's knob's, 100′ above Washington coal.

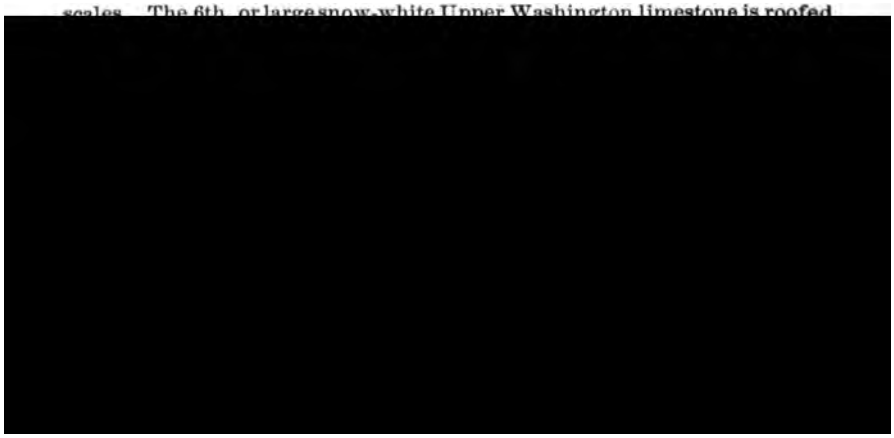
The *Jollytown coal horizon* is reached in Redstone twp. of Fayette along the National Road; but the great middle Washington limestone has totally disappeared. Limestone III occurs in Redstone on the pike, ferruginous and incomplete, but elsewhere it seems wanting.

The Lower Washington limestone is present but indistinct in German twp. and Redstone twp. on Dunbar creek, above Merrittstown. In Rostraver and S. Huntingdon twps. of Westmoreland it shows an excellent character, 6′ to 10′ thick.

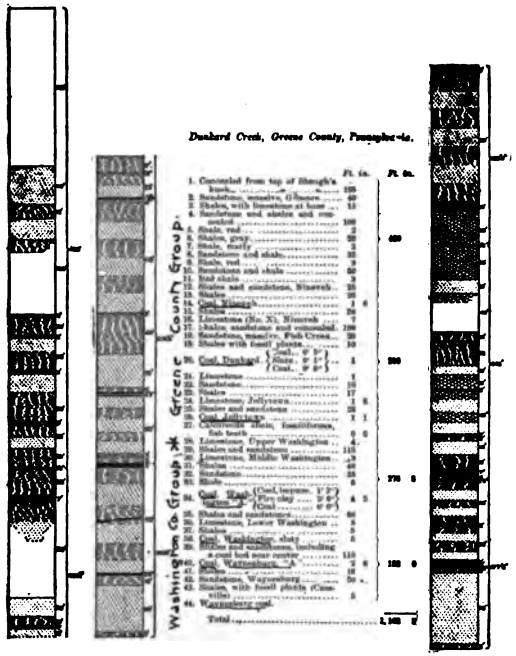
The *Washington coal bed* was observed in German, Redstone, Luzerne, Jefferson and Washington twps. of Fayette

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scales. The 6th, or large snow-white Upper Washington limestone is roofed



No XVI. Upper Barren Measure Series. Vertical Sections in Greene Co. I. C. White Bull. 65. U.S.G.S.



Washington Co. Group. Greene County Group.

Dunkard Creek, Greene County, Pennsylvania.

		Ft. in.	Ft. in.
1.	Concealed from top of Waynesburg "A" coal to Waynesburg sandstone	125	
2.	Sandstone, massive, Glassers	40	
3.	Shales, with limestone at base	15	
4.	Sandstone and shales and concealed	100	
5.	Shale, red	2	
6.	Shales, gray	25	600
7.	Shale, marly	5	
8.	Sandstone and shale	35	
9.	Shale, red	3	
10.	Sandstone and shale	50	
11.	Red shale	3	
12.	Shales and sandstone, Waynesburg	35	
13.	Shales	25	
14.	Coal, Waynesburg "A"	1 6	
15.	Shales	70	
16.	Limestone (No. X), Waynesburg	10	
17.	Shales, sandstone and concealed	190	
18.	Sandstone, massive, Fish Creek	30	
19.	Shales with fossil plants	10	
20.	Coal, Pinnacle { Coal 2' 2" / Shale 2' 2" / Coal 2' 2" }	1	550
21.	Limestone	1	
22.	Sandstone	10	
23.	Shales	17	
24.	Limestone, Jollytown	1 6	
25.	Shales and sandstone	25	
26.	Coal, Jollytown	1 1	
27.	Calcareous shale, fossiliferous, fish teeth	6 6	
28.	Limestone, Upper Washington	4	
29.	Shales and sandstone	115	
30.	Limestone, Middle Washington	3	
31.	Shales	60	
32.	Sandstone	55	770 0
33.	Shale	6	
34.	Coal, Nine-foot { Coal, bottom 2' 2" / Fire clay 2' 2" / Coal 2' 2" }	4 6	
35.	Shales and sandstones	60	
36.	Limestone, Lower Washington	5	
37.	Shales	5	
38.	Coal, Washington, shut	6	
39.	Shales and sandstones, including a coal bed near center	110	
40.	Coal, Waynesburg "A"	3 6	320 0
41.	Shales	10	
42.	Sandstone, Waynesburg	30	
43.	Shales, with fossil plants (Cassville)	5	
44.	Waynesburg coal		
	Total	1,365 6	

Calvin's Run, Greene County, Pennsylvania.

		Ft. in.	Ft. in.
1.	Limestone, Waynesburg	9	
2.	Shales and sandstone	125	
3.	Limestone, Jollytown	10	320 0
4.	Sandy shales	35	
5.	Coal, Jollytown	1 6	
6.	Shales, sandy	25	
7.	Sandstone, massive	35	
8.	Sandy shales and concealed	60	
9.	Red shales	30	
10.	Shales	25	
11.	Sandstone	30	
12.	Shales	15	
13.	Coal shales, Washington, "A"	2	
14.	Sandy shales and sandstone	65	345
15.	Limestone, gray	5	
16.	Shales	5	
17.	Sandstone, massive	10	
18.		15	
19.	Limestone, Washington Lower	7	
20.	Slate, dark	2	
21.	Coal, Washington	2 6	
22.	Shales and sandstone	45	
23.	Coal, Waynesburg, "B"	2	
24.	Shales and sandstone	30	
25.	Limestone, Calvin's Run	2	
26.	Shales	1	
27.	Coal, Waynesburg, "A"	2	
28.	Limestone	2	
29.	Shales	4	
30.	Sandstone, Waynesburg	75	
31.	Shales, with fossil plants (Cassville)	6	
32.	Coal, Waynesburg		
	Total		677 6

Near Taylorstown, Washington County, Pennsylvania.

		Ft. in.	Ft. in.
1.	Limestone, in fragments	0	
2.	Shales and sandstone	20 0	
3.	Coal, blossom, Jollytown	2 0	
4.		20 0	
5.	Limestone	2 0	
6.	Concealed	20 0	
7.		15 0	
8.	Sandstone	15 0	
9.	Coal	2 0	320 0
10.	Concealed	60 0	
11.	Limestone	15 0	
12.	Concealed	15 0	
13.	Concealed	15 0	
14.	Limestone	15 0	
15.	Concealed	15 0	
16.	Concealed, with much limestone	20 0	
17.	Coal, Washington	2 0	
18.	Concealed, with a limestone	20 0	
19.	Coal, blossom, Waynesburg "B"	2 0	
20.	Concealed	40 0	
21.	Coal, blossom, Waynesburg "A"	2 0	31
22.	Waynesburg sandstone	20 0	
23.	Shales	15 0	
24.	Coal, Waynesburg	2 0	
	Total		351 0

Plate 529.

and in Rostraver and S. Huntingdon of Westmoreland, where its horizon is also reached though not seen, in Sewickley and N. Huntingdon. In German twp., where alone the bed is well exposed in Fayette Co., it shows 4′ 10″ thick, with coal benches of 0′ 4″, 1′ 1″, 0′ 11″ and 1′ 2″ separated by clay partings of 1′ 3″, 0′ 6″ and 0′ 5″. In Westmoreland Co. it shows an extreme thickness of 9′ in S. Huntingdon twp., composed of alternating layers of slate and slaty coal. The coal in both counties is inferior and the bed varies abruptly in sections; so that it is everywhere commercially worthless.

The *Waynesburg "a" coal* is everywhere persistent in the Lisbon basin, but always thin and resting directly on the Waynesburg sandstone. This latter stratum was observed in nearly all parts of the Blairsville basin where the measures are preserved, sometimes thinly bedded and laminated and elsewhere a compact rock, ripple-marked. In the Lisbon trough, in Fayette, it is compact below and flaggy above. Northward in Westmoreland it becomes shaly and poorly exposed.

(a) *The Washington Co. group in Greene and Washington Cos.*

The rocks of this lower sub-division of the Upper Barren Measures outcrop in the sides of all the valleys of the western townships of Greene Co., along branches of Wheeling creek, and the Courtney fork of Ten Mile creek. Rising gently northward they take possession of two-thirds of the surface of Washington Co. In Greene Co. they occupy the high ground of the eastern townships, and for ten miles south of the Washington Co. line, the lowest beds of the series look down into the valley of the Monongahela, and across it to similar outcrops at the same level in Fayette Co.

Were it not for the limestone members and two of its coal beds, the order of its rocks would be difficult to make out; *first*, because it is a series of indistinguishable coal measure shales and soft sandstones and *second*, because the

total thickness of the group varies from 400′ on the West Virginia line to only 150′ in north-western Washington Co. In this latter county we may study this interesting group in its best condition with its one great (Washington) coal bed and its many fine limestones. In Greene Co. with its growth in thickness and coarseness southward, the thinning away of its limestones and the Washington coal, and the compensatory thickening up of the still lower Waynesburg coal at the top of the Upper Productive group. The generalized sections given in plate 530 represent in a general way the order of the beds and the difference in character of the group in the two counties.*

The *Washington upper limestone*† or *Sixth limestone*, separating the two divisions of the group, is characterized by the snow-white color of its weathered outcrops; by the fetid odor of some of its layers, full of broken fossil shells; by the fish remains in its roof shales; and, in Washington Co., by its yielding excellent macadam road material. It thickens northward from 3′ in Greene Co. to 30′ in Washington Co., but only averages 4′ to 8′ over the region. It lies on sandy shales in Greene Co. and on massive sand-

*It must be carefully recollected that a thousand variations take place from township to township. Sand rocks become shaly and shales become coarse sand rocks; limestones are sometimes mere lime-clays or lime-sands and then resume their purer and more massive form. Coal beds thicken and thin, grow rich or poor, pass into black slates or entirely disappear for

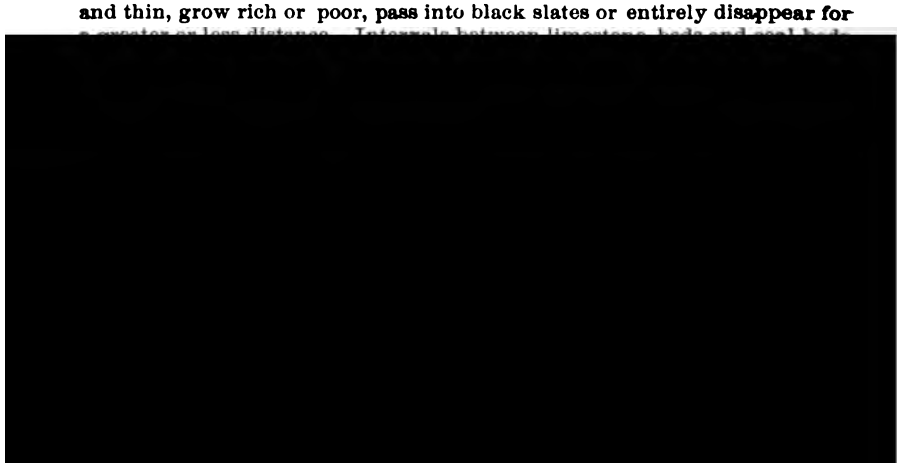
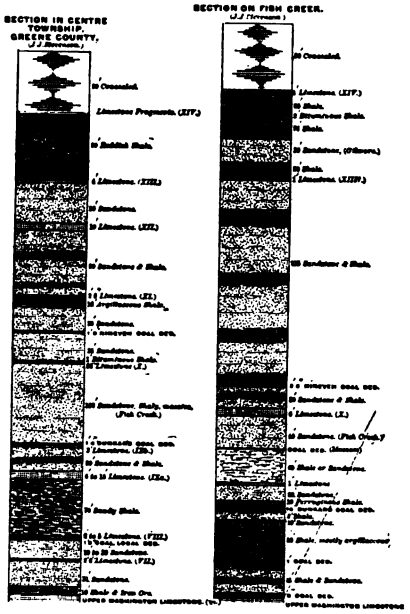


PLATE 530

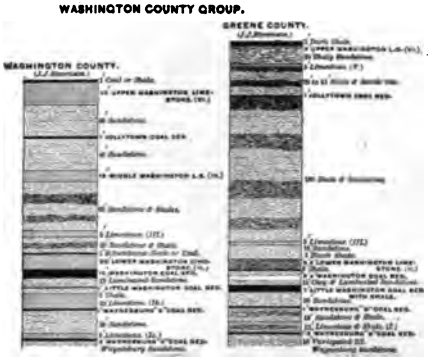
N°XVI. Upper Barren Measures: south-west Penna

GENERALISED SECTIONS OF THE UPPER BARREN MEASURES IN GREENE AND WASHINGTON COUNTIES.

GREENE COUNTY GROUP.



WASHINGTON COUNTY GROUP.



stones in Washington. The fish-bed roof of this Sixth limestone is a black shale, with cannel coal fracture (in one place becoming a thin coal bed)* containing vast numbers of small bivalve crustaceans and fish-scales, all well preserved; and in some places crowded with the long slender leaves of the *Sigillaria menardi*, one of the gigantic moss-trees of the coal age. The upper limestone layers are slaty, with a blue color on fractured surfaces. The middle layers are dark, almost black; brittle, resisting the weather, good for road material, and making superior lime.† The lower layers are light flesh-colored, less brittle, more easily weathered and hardly less excellent to burn.‡

At Washington, in Cemetery Hill, the whole mass is sub-divided into many layers, as follows:

Limestone, laminated, clayey; top member,		2	
Shale { dark, with bivalve crustaceans,		5′	
Calcareous,		6′	13′
with vegetable impressions,		2′	
Limestone,	0′ 10″		30′ 3″
Black shale,	0′ 10″		
Limestone,	2′ 0″		
Calcareous shale,	1′ 3″		
Limestone,	1′ 6″	15′ 3″	
Shale,	0′ 10″		
Limestone,	3′ 0″		
Shale,	2′ 0″		
Limestone,	3′ 0″		

This enlarged section is by no means a type; its variations are infinite. Only 1 mile east, in the railroad tunnel, instead of 11 alternate layers of limestone and shale 30′ thick, there are nearly 20′ of solid limestone. Elsewhere both in character, arrangement and thickness, it shows the greatest variability; still it is of economical importance, even when thin, on account of its excellent lime, and of geological value as a persistent key-rock horizon to cal-

*On Dunkard creek, Gilmore, 1 mile above Jollytown.

†Contain great numbers of little bivalve crustacean fossils, which are quite characteristic of all the limestone beds of the Upper Barren Measures.

‡The upper and lower divisions persist over the whole region; the middle division thins southward and disappears in Greene Co.

culate approximately the interval intervening to the *Washington coal bed.**

Iron ore occurs over the black shale roof of this limestone only in Centre twp., Greene Co., at head of Pursley creek, as clay iron-stone balls (carbonate of iron);† elsewhere ore of workable value is unknown to these highest Greene Co. coal measures. It occurs as five layers, summing up nearly 3′ of ore in 20′ of measures.

The interval between Limestones VI and V is in Greene Co. a shale 20′ to 30′ thick; but in Washington, where the fifth limestone is wanting, a sandstone mass about 80′ thick, holding the Jollytown coal bed in the middle of it.‡

Limestone No. V is almost wholly confined to Greene Co., where it is widely persistent; it is a hard, coarsely brecciated rock, 2′ to 5′ thick, weathering to a dull grey, compact rock, making a clean cut outcrop, acting thus as an excellent geological guide, in conjunction with Limestone No. VI, 20′ to 30′ above it. It is prominent on Ten Mile creek above Waynesburg, going under water level near Centre-Jackson line. Along Dunkard creek it is thin (1½′). It goes under water level above Jollytown in Gilmore and scarcely reappears on Fish creek in Springhill. In the interior townships, as at Waynesburg, it lies 20′ to 30′ above the Jollytown coal bed.

The *Jollytown coal* lies about 30′ below 5th. limestone

*This interval however is not constant. The Washington coal underlies

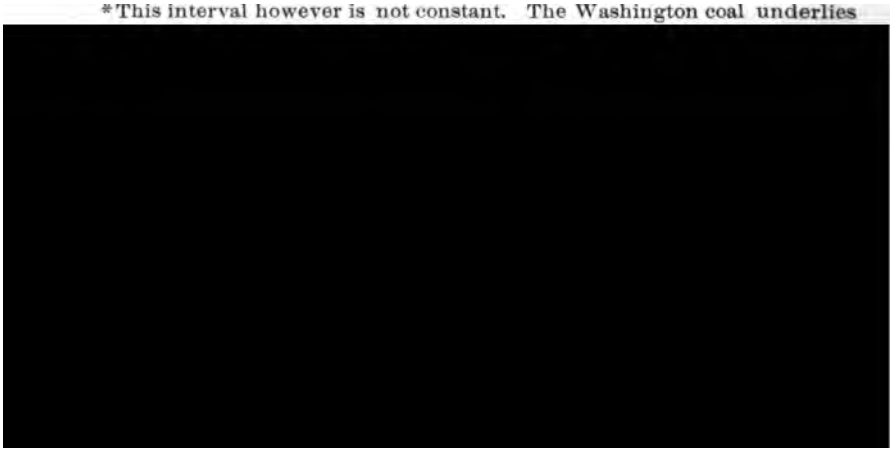
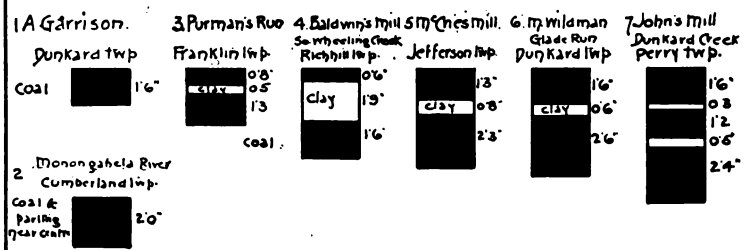


PLATE 531

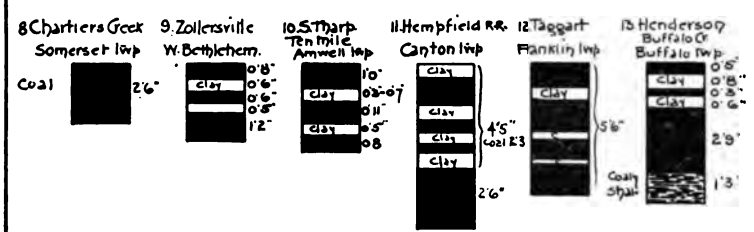
No XVI. Upper Barren Measures: Washington County Group.

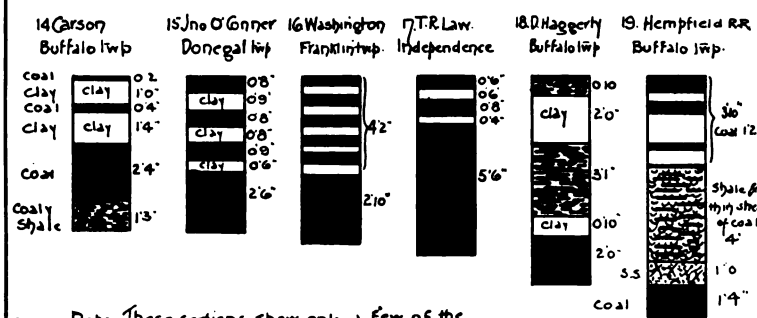
Vertical Sections of Washington Coal Bed.

1 GREENE COUNTY.



2 WASHINGTON COUNTY.





Note. These sections show only a few of the many types of the Washington coal. For details and particulars, see Rep. K.

in Greene Co., but in Washington, where that limestone is wanting, it occurs at various distances of from 2′ to 30′ below the 6th. limestone. It is of some local value along Dunkard creek (1½′ thick) and it is remarkable that so thin a coal should be so persistent over so great an area. It reaches its maximum (2′) in Hopewell and western Franklin, Washington Co; but it nowhere has any economical value, except in the coalless region of S. W. Greene Co., where the Waynesburg coal beds can only be reached by shaft 200′ to 350′ deep.

The *Jollytown sandstone* is a massive sand deposit, of irregular structure, weathering into fantastic forms, appearing at many localities and helping the geologist to identify the Jollytown coal bed above it. At Lantz's, ⅜ miles below mouth of Hoover's run on Dunkard creek, it occurs 70 immediately under the coal.

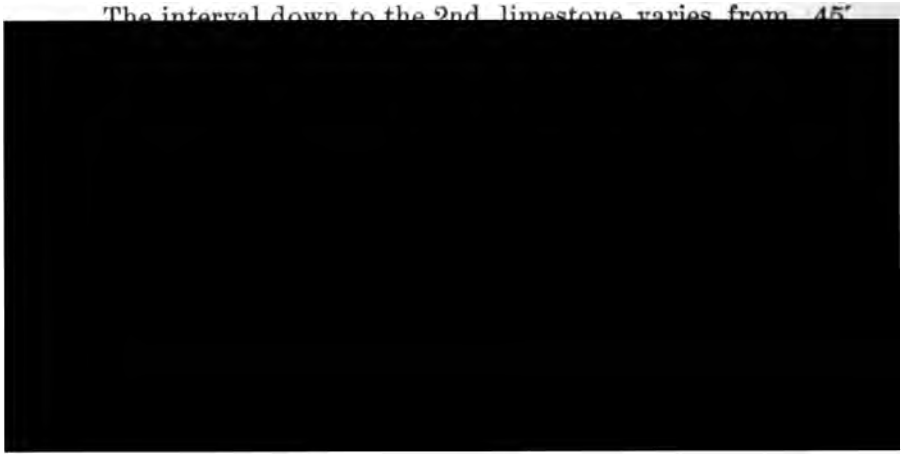
The *Middle Washington limestone No. IV*, 3′ to 20′ thick, is almost confined to Washington Co. It may be identified by its dull flesh colored fracture, with innumerable specks of calcspar; by its rusty yellow outcrops, scaling and crumbling because of the heavy charge of iron, and by multitudes of minute fossil whorls and shells and occasional fish spines. It usually rests on a little coal bed. The upper layers contain most iron and are richly fossiliferous; but as the fossils are not silicified they can rarely be extracted perfect enough for identification. Its most north-western outlier has been preserved in Jefferson twp., Washington, between Burgettstown and Eldersville. No traces of it appear in Allegheny and it thins southward towards Greene Co. Its frequently great size, peculiar looks, and constant companionship with the 6th. limestone above it in Washington Co., serve to make it an additional aid for determining the position of the underlying coal beds of the Upper Productive measures. It has little value for lime-burning.

The interval between this Limestone No. IV and the Washington coal bed contains the 3rd. and 2nd. limestones and two or three thin coal streaks, spread through a mass

of sandstone and shale. The *Washington coal "a"* lies between the 4th. and 3rd. limestones. Over it, in one place on Dunkard creek, are seen 75′ of sandstone beds, and under the 3rd. limestone are 40′ more; the rest of the 150′ interval is made up of 5′ of limestone and 25′ of shales and limestone. But the proportion and interval are different at every new outcrop, so that no general statement can describe the infinite changes. But followed north into Washington and west towards the Ohio State line, this interval certainly diminishes to 85′, 80′ and 70′; northward in Mt. Pleasant only 30′. It would appear to be generally true that just as the 6th. and 4th. limestones gradually come together coming northward and squeeze out the 5th. limestone, so also do the 4th. and 2nd. approach one another and eliminate the 3rd. limestone from the northern field.

The *Limestone No. III* varies in color from light blue to buff and is usually rather thin. Throughout Greene it lies from 40′ to 70′ above the Washington coal, the 2nd. limestone being very thin. In Washington, where this latter rock becomes much thicker, the 3rd. becomes thin and may be readily mistaken for the top of the 2nd. limestone. Two miles north of the Williamsport pike in S. Strabane it is 8′ thick, 20′ above 2nd. limestone and has a black shale roof, containing many fossil *lamellibranchs* (scallop shells), with fish scales, some quite large.

The interval down to the 2nd. limestone varies from 45′



times with coal), quite fossiliferous (bivalve crustaceans; fish scales; plants). In Washington it varies greatly in thickness from 20′ at Washington to 5′ at Eldersville; from 6′ at Claysville to almost 20′ across the State line.

The *Washington coal bed** underlies the 2nd. limestone, and is apparently as persistent throughout its area of occurrence as the Waynesburg and Pittsburgh beds of the underlying Upper Productive Series. It extends southward into W. Va. and westward into Ohio, limited northwest to Eldersville in Jefferson twp. and to the Allegheny-Washington line northward. Its thickness varies from less than 1′ in Greene to 11′ in Washington Co., where it is mined in Amwell, Morris, Franklin, S. Strabane, Donegal, Buffalo and Canton twps. It is thick enough for mining in Jefferson, Hopewell, Mt. Pleasant and Independence; but like the Waynesburg bed, its mining value is ruined by numerous clay partings. Numerous sections of this bed, the only large seam of the Washington group, are given on plate 531 which sufficiently show its character and excessive variation.†

*This coal bed has been called the "Brownsville bed" from a village in W. Va. It has also been identified as Coal No. XIII, of the Ohio Survey.

†*Greene Co.* At Garrison's in Dunkard 160+Way. C. and 1′6″ thick. In Perry, below Rudolph's run, three benches 1′ 6″ (3″) 1′ 2″ (5″) 2′ 4″ and 5 8″ thick; lower bench mined for neighborhood; ashy, sulphury; made worse by mixture with other benches. Floor shales contain some good leaf impressions, chiefly *Neuropteris* (K. 106). In Jefferson, at McCrees mill 1′ 3″ (8″) 2′ 3″=4′ 2″; lower bench good (K. 140). In Franklin it is 2′ 4″ but poor coal on Purman's run; and on Smith's creek double, 3′ thick. In Morris, Jackson and Alleppo it is buried; in Richhill only 6″ on Mill run; 1′6″ on Crabapple and + 155′ Way. C.; at Baldwin's mill many deserted drifts, 6″ (21″) 18″=3′ 9″ (perhaps a third lowest bench); coal slaty, (K. 171).

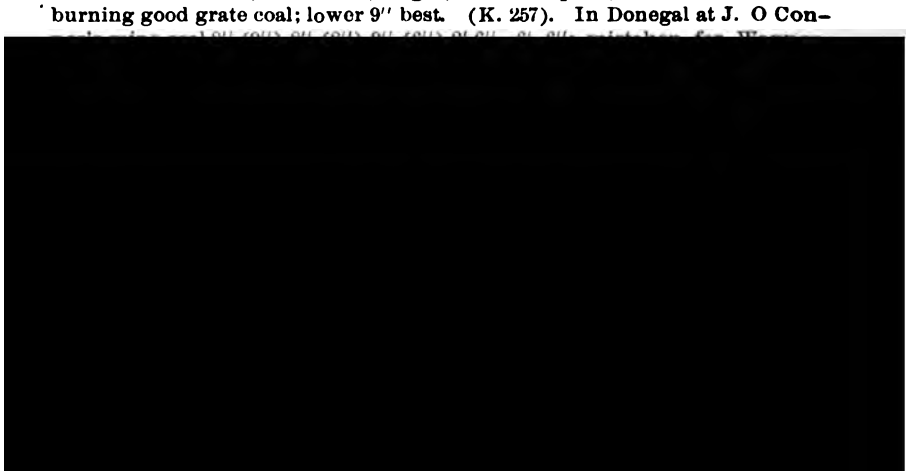
Washington Co. W. Bethlehem 1½ m. above Zollarsville it is in three plies, 8″ (6″) 6″ (5″) 14″=3′ 3″ and 95′ above Way. C.; at Pleasant Valley 80′ (K.182). In Amwell 3′ thick, eastern side; on Ten Mile run 12″ (3″–7″) 11″ (4″–6″) 8″=3′ 6″; very poor, merely black slate (K. 188). In S. Strabane, N. of Washington, 4′ thick (110′+Way. C.) (K. 241). In Canton 7′ thick in eight plies of coal and clay; bottom bench 2′ 6′, poor, slaty coal (K. 245). At Taggart's mine, seven plies of coal and clay 4½′ of coal in 6′. In Franklin 11 plies of coal and clay at Washington brick yard, bottom bench 2′ 10″; total 7′ and 440′+P. C. (K. 248). In Hempfield R. R. cut, 5′ under 2nd. l. s.; holds 4′ 8″ of coal in 6′ 4′; not much pyrites but

In a railroad cut just east of Washington it is divided by clay partings thus: coal 3″ (8″) bit. shale 10″ (15″) coal 5″ (1″) 2″ (2″) 3″ (3″), bottom coal 2′ 9″=7′ 1″ total thickness. In another cut eight miles west, thus: coal 4″ (24″) 2″ (2″) 3″ (6″) 5″ (shale with streaks of coaly matter 48″; sandstone 12″) 16″=10′ 2″ total thickness.

Ordinarily it is constituted as on Ten Mile creek in Amwell, thus: coal 12″ (3″ to 7″) 11″ (4″ to 6″) 8″=3′ 5″ total thickness. In Greene Co. it is seldom thick enough to work (see plate 531 figs. 1 to 7) usually about 18″; on Hunters fork in Richhill, only 6″. But it is always double, with a clay parting in the middle. The quality of the Washington coal will not bear comparison with the Pittsburgh coal, its best analysis showing F. C. 46.70; V. M. 39.10; ash 10.50: sulphur 2.0; water 1.70; ash grey; coke 59.2; ash in coke about one-sixth.* Usually the coal is inferior to this sample in both ash and sulphur; largely due to the fact that the numerous alternations of coal and clay must be mined together, to which is added the difficulties of mining a bed which varies in thickness so frequently and greatly and so cut into by clay veins and horse backs.†

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very ashy. (K. 250). In Buffalo at Haggerty's 11 bands of coal and clay bottom bench 2′; in all 4′ 3″ of poor coal in 8′ 9″ (K. 254). At Taylorstown, Henderson's mine, coal 5″ (8″) 3″ (6″) 33″ (coaly shale 15″)=5′ 10″. Carson's mine coal 2″ (12″) 4″ (16″) 28″ (coaly shale 15″)=5′ 5″, main bench becomes 3′ and 3′ 6″, handsome, bright, little sulphur, but half ash, free burning good grate coal; lower 9″ best. (K. 257). In Donegal at J. O Con-



Its vertical height above the Waynesburg coal varies from 150′ in the south to 50′ in the north.

The *Washington sandstone*, underlying this coal and separated from it usually by a few feet of fireclay, is a remarkable deposit. It is a laminated sandstone, made up of innumerable thin layers of fine sand and mica flakes; minute fragments of fossil wood and bits of leaves. Occasionally some thin clay layers near the top show many well preserved fern impressions, chiefly *Neuropteris*. There is no other deposit like this one in the Barren Measures of Greene Co.; but a similar bed was afterwards deposited in Washington Co., almost directly upon the 4th. limestone at one place, and a few feet over the 6th. limestone at another: but they are both less distinctly laminated; are not so crowded with plant fragments and are not gashed with vertical clay seams.

The *Little Washington coal* lies beneath the laminated sandstone, everywhere thin, but very persistent. Throughout Greene Co. it is merely a bed of dark, slightly bituminous shale. In Washington it carries thin coal layers in this black shale, and lies in innumerable waves, 2′ to 3′ deep and 6′ to 30′ wide, adding to or subtracting from the thickness of the overlying shale and sandstone without at all disturbing the Washington coal.

The *Taylortown limestone 1b* underlies the Little Washington coal at all exposures in western Washington Co. north of Hunter's fork, but separated from it by fire clay or shale 2′ to 10′ thick. The limestone itself is 10′ thick on Hunter's fork increasing north to 20′ on the Hempfield R. R. and 25′ on Buffalo creek, by the addition of ferrugi-

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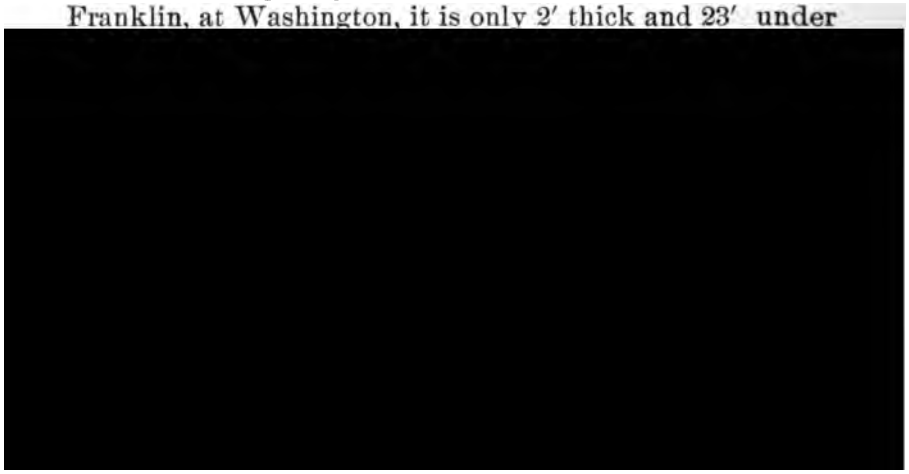
and these alternations are so arranged that while the thickness of the whole deposit varies greatly, the total thickness of actual coal remains constant over considerable areas, showing that while the growth of the swamp vegetation was about the same everywhere, it was interrupted locally more frequently and to a greater extent in one place than another, by the income of more or less muddy or sandy silt. It is evident that the water in which the swamp vegetation of this bed grew was not absolutely still and pure water like that in which the Pittsburgh and other fine solid coal beds were quietly formed; but was on the contrary subject to decided, although broad and gentle currents, bringing in the finer material of some great river.

nous top layers. The limestone is compact and massive, but too impure to make good lime. It does not extend east to the north fork of Ten Mile creek in Franklin twp., nor does it appear in the Pigeon creek country, nor in Greene Co., where the whole interval down to the Taylortown coal (20′) is filled with sandstone or sandy shale.

This *Taylortown coal* (or Waynesburg "B" coal of Report K) is sometimes good, sometimes merely black shale 6″ to 18″ thick. It is seen at most places where the lowest rocks of the series are exposed; but is of no economical importance whatever.

The *First limestone* (*1a*) of the Upper Barren Measures is very persistent, but often becomes thin and turns into shale. In many places it is pure enough to be burned for for lime. Lying so close to the Taylortown limestone (1b) it has been frequently mistaken for that higher bed, especially in western Washington, where the interval is very small.

At Waynesburg the 1st. limestone is doubled by a shale parting. In Greene Co. it shows limestone and shale 13′ at Hook's dam in Franklin twp.; in Perry only 1′ thick. In Washington Co., Amwell twp. it is 12′ thick, overlying the Waynesburg "a" or Zollarsville coal 2′ thick. In N. Strabane 20′ thick south of Presbyterian Church and is handsomely exposed in Canton 10′ thick, from 2′ to 10′ beneath the undulating Taylortown coal, and ferriferous. In Franklin, at Washington, it is only 2′ thick and 23′ under



cial value. It is seldom good; only worked on Muddy creek. in Greene Co., and is mainly used as a key, being the first coal bed above the great Waynesburg sandstone formation.

The *Martinsburg limestone* is a fairly local deposit, underlying this coal and making a good lime. It is the heavy limestone burned on Bacon Street run, Morgan twp., and elsewhere, and is also frequently found beneath coal XII in Ohio.

The *Waynesburg sandstone*, at the base of this group,* is one of those great sand and gravel formations which were periodically spread over the bed of the carboniferous sea, putting an end to one series of coal and limestone strata and preparing the ground or water for another. Its thickness in Penna. nowhere exceeds 75′ and is often only 50′. It grows finer and thinner northward and turns into shale in middle and north-western Washington Co.

But in the valleys of Wheeling creek and in all the side valleys of the Monongahela south to the State line and into central W. Virginia, it forms bold cliffs of massive sandstone, often holding beds of gravel mixed with feldspars and, and sometimes wholly a mass of quartz pebbles ($\frac{1}{4}''$ to $1''$ in diameter). In the Monongahela valley it is double, its equal upper and lower divisions separated by layers of sandy shale, occasionally turning to flagstones. The upper is always cross-bedded, flaggy rock; the lower is sometimes flaggy and hard enough for building purposes, but usually a soft and massive sand mass, standing in bold cliffs 40′ high (as at Waynesburg) crumbling in the air, honeycombed, containing wind caves and narrow passages. Soft as the rock is, its color is so agreeable and it dresses so easily, that it is much quarried for building stone.

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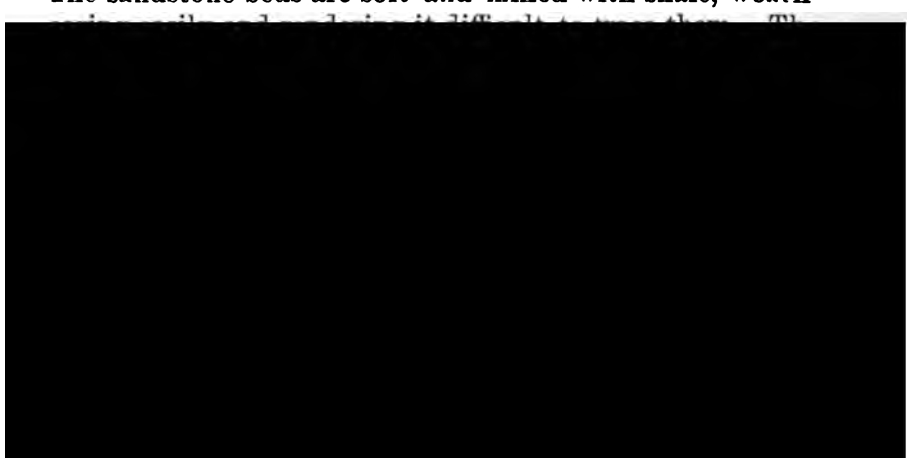
*In Reports K, K K, Dr. Stevenson placed it at the top of the *Monongahela River Series;* but as the *Conglomerate No. XII* has been placed at the base of the *Allegheny River Series*, and the *Mahoning sandstone* at the base of the *Pittsburgh Series*, there seems to be every reason for assigning it to the base of the *Upper Barren Measure Series* in this district.

East of the river in Fayette Co., it has already been described as making cliffs 70′ high, as a single mass of solid sandstone, mostly well fitted for building purposes; often marked by a concentric structure; light gray to bluish gray in color; coarse-grained and micaceous, and holding small grains of feldspar which weather out and leave the surface rough and open. It is typically seen west of Waynesburg on the branches of the south fork of Wheeling creek, in Richhill twp: over the many Crabapple mines and lying on the coal it forms cliffs 65′ high and caves 30′ to 40′ deep. In Washington Co. it is 55′ thick in West Finley twp., lying on the coal for ¾ miles along Croup's creek and ranges about 50′ thick wherever its horizon is exposed, often causing great irregularity of section in the underlying Waynesburg coal bed. Many details concerning it will be found in Report K.

(*b*) *The Greene Co. Group in Greene and Washington Cos.*

The *Greene Co. group*, or upper division of the *Upper Barren Measures*, has naturally a much more limited outspread than the Washington Co. group just described, and has a maximum thickness of 800′, with infinite variation.

The two coals, the *Nineveh* and *Dunkard beds*, are both thin and variable, but wide spread. The limestones are also thin, seldom over 1′, but locally thicken to several feet. The sandstone beds are soft and mixed with shale, weath-



In S. W. Greene the highest beds are found, the first 80′ to 100′ being concealed by weathering. The next 80′ to 100′ consist of red shale measures, (much thicker and more prominent in West Virginia). The *14th. limestone** of the series, measuring from the Waynesburg coal, lies on top these red shales; the *13th. limestone*† underlies them; and they are confined to the four southwest corner townships of the county, and the hill tops of Richhill, E. & W. Finley to the north. In Gilmore twp. a thick sandstone splits the red shale into two divisions. It caps the highest hills, nowhere over 30′ thick, but making a great show of cliffs, weathering into caves and fanciful shapes.

The next underlying 300′ of measures are soft sandstone and shale, containing along Fish creek only the thin *Nineveh coal* near base; and at the bottom the *10th. limestone*, 6′ thick.‡ But on Courtney fork, descending towards Waynesburg, under 50′ of hard sandstone, comes the *12th. limestone* § (10′); then 80′ lower the *11th. limestone* ‖ (2½′); then clay shale (12′); then the *Nineveh sandstone* 60′ thick with the *Nienveh coal bed* ° (1½′) in the middle of it; then the *10th limestone* (2½′) with its roof of dark shale carrying plants and fish teeth. In Aleppo twp., along Dunkard fork of S. Wheeling, from the 14th. limestone (4′) down to 10th., limestone (8′) is 413′.

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* Fragments west of Waynesburg; 4′ thick at head of Aleppo fork of Wheeling creek, dark blue earthy limestone; minute crystals of blende; occasional fish scales. (K. 38)

† Can be followed from a mile east of Hopewell church westward to Graysville in Richhill, 4′ thick, half shale and half limestone.

‡ The 12th. and 11th. limestones are absent along Fish creek.

§ Well seen in Morris and Centre; 15′ thick, limestone and shale. It is perhaps the 8 limestone in E. Finley, 230′ above the 6th. limestone, although at Nineveh it lies 300′ over same rock.

‖ Imperfectly exposed below Graysville; best seen opposite Nineveh.

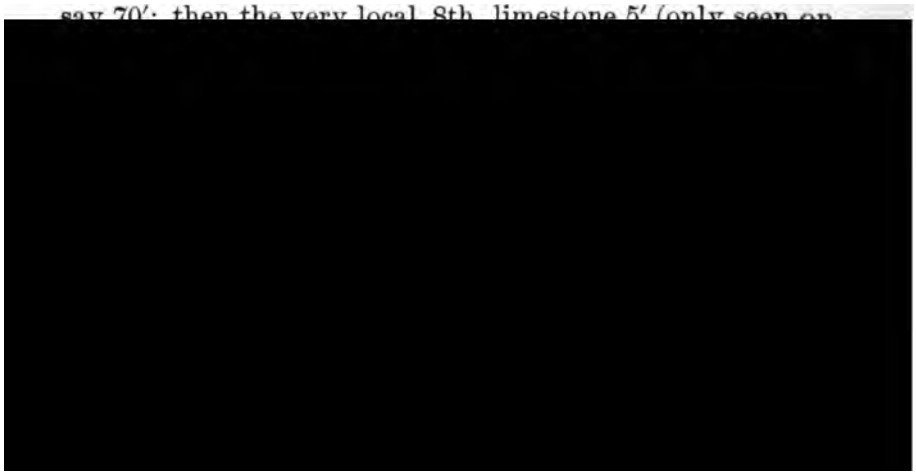
° Seen on Short creek, Sparta neighborhood, above 10th. limestone (K. 192). Also on Hargus creek (Centre twp. Greene) 30′ above 10th. limestone (K. 155). At White's Cottage (Jackson) stripped, 1½′ thick and good. (K. 162). Also on Brown's fork and elsewhere, below Nineveh 18″ to 20″, where it is important as the only source of supply until deep shafts are sunk to the Washington, Waynesburg and Pittsburgh coal beds.

The *Fish Creek sandstone* occupies the 100′ interval below the 10th. limestone, making cliffs, and furnishing good building stone. The western half of Greene Co. is supported by this formation, which once spread over Washington Co., but has long since been swept away. An outlying fragment of it seems to cap the high knob at Hillsborough in Bethlehem twp., 10 miles south-east of Washington.

Under the sandstone, but only in S. W. Greene, appears the little *Dunkard coal bed*, thinning away northward and and disappearing in Richhill twp., showing only 14″ in Gilmore twp. In Jackson it varies from 14″ to 21″; in Springfield* seldom more than 10″; in Centre 18″ to 20″, and absent entirely in the Nineveh district on Brown's and Hunter's forks. Under this coal the 9th. limestone spreads through the Nineveh basin south-westward, not extending across the Pin Hook axis towards Waynesburg, nor across the Washington axis westward, nor along the basin northward; for the interval between the 10th. and 6th. limestones thins in that direction to half its size by the disappearance of many of its beds.

The *9th. limestone* does not appear in Washington Co.; nor on Brown's and Ruff's forks; but on Gray's fork it is 6′ to 10′ thick; on Courtney's fork 6′ to 8′; thins down Dunkard creek to 1½′ above Jollytown; disappears along Fish creek, but shows again on S. Wheeling creek.

Still lower in the series comes a sandy shale formation say 70′; then the very local 8th. limestone 5′ (only seen on



Greene Co., but thick and pure in Washington Co.; then sandstone 30′; shale, with iron ore, 10′; and then the 6th. or Upper Washington limestone, the top of the Washington Co. group.

It is impossible to identify with certainty many of the thin limestones of this *Upper Barren Measure Series*. Most of them may be regarded as deposits of mud, charged with an extra percentage of carbonate of lime, and as such they pass insensibly into common shale in various directions, from one locality to another. The more massive layers of the underlying *Washington group* and *Monongahea River Series* were evidently deposited in deeper water and therefor spread in more continuous sheets through much larger areas of country.

The following interesting discussion of the *Coal Measure Limestones*, by Prof. Lesley, may fittingly close this chapter:

"The limestone beds of the Coal Measures are mysterious deposits. No adequate explanation has been suggested. It is not certain that they all belong to one kind. In other words, some may be the product of a change in the character of the stuff brought from the land into the sea by rivers; while others may be the product of animal or vegetable secretion. It is not even possible to decide positively whether the water in which they were deposited was shallow or deep; fresh, brackish or salt. Arguments can be advanced to sustain any of these views.

The depth of water must have been very moderate; probably never more than 100′. This point in the case seems to be pretty surely decided by the interval distances between the coal beds; for each coal bed represents either an absolute sea level, or a bog surface over low lands or sand and mud flats; and the interval between coal bed and coal bed, made up of sandstone, shale and limestone strata, and representing an expanse of water many miles in length and breadth, is never more than 100′, and usually less than 50′.*

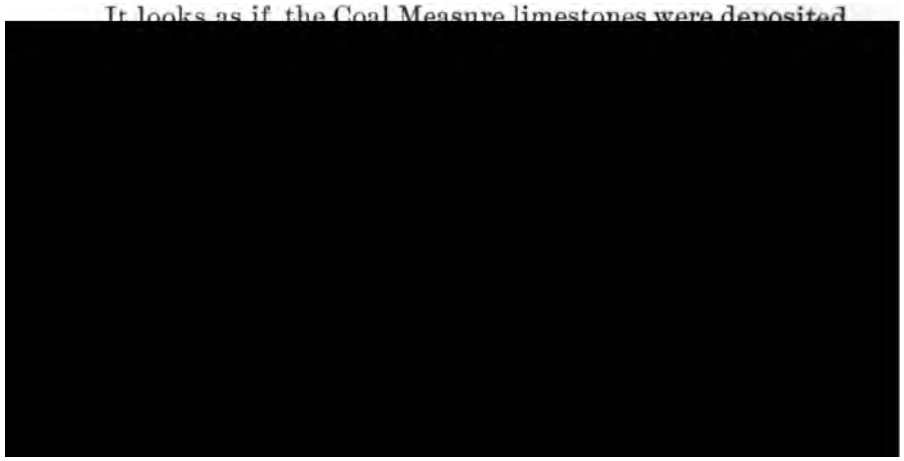
*The argument is confined to the *Productive Coal Measures.*

It seems to be demonstrated by all known facts relating to the subject, that the Atlantic region gradually settled during the Palaeozoic ages to a depth of five miles, carrying down with it the adjoining region on the west to depths of four, three, two and one miles, according to the distance westward, for a thousand miles; and that during this gradual but unequal settlement of the whole sea-bottom, all the Palaeozoic sediments were deposited; faster and thicker where the downward movement was more rapid; slower and thinner where it was less rapid.*

Towards the close of this long process, the general water basin from the edge of the Atlantic Highlands to beyond the Mississippi had become filled up nearly or quite to its surface, and converted into a vast swamp, or congeries of islands, swamps and lagoons, covered with a continuous forest, growing on peat bogs, partly in the air, partly in the water, partly floating on the water; through which universal forest meandered many large and innumerable smaller currents of water, leisurely finding their way westward towards the still deep and open ocean of the world.

But still the downward movement went on; but at a much slower rate; a rate so slow as to amount to practical stability; permitting vegetation to exist at or about sea level for centuries at a time; and when submerged and killed in one region, to re-establish itself by spreading back from surrounding regions, where it had not been overwhelmed.†

It looks as if the Coal Measure limestones were deposited



in these waterways of the vast forest swamp, widening out here and there into lakes; small secluded, protected shallow pools, invaded by the surrounding sphanum, or covered by by it, and beginning to sustain large trees; or, large sheets of open water, inland seas, studded with islets, and exposed to the tempests of each season, tossing their cross waves from shore to shore; some, communicating with great rivers, Amazon or Orinoco, Mississippi or Hoang Ho, Ganges or Indus, Niger or Congo, of that ancient time, and receiving the sifted contributions of its mountain spoils; others, buried in the abysses of the swamp-forest, fed only by the rainfall, and receiving the finest silt which percolated to them through surrounding mud flats and sandbanks.

One thing is certain; there was no true seashore anywhere in or near this world of coal bed making vegetation; and all attempts to refer its phenomena to agencies resembling those which operate along our modern coasts can only result in mistake and confusion of mind. Nor will any theories of coal formation bear good fruit that take as their starting point for argument the action of modern hill country rivers, whether flowing through forests or not. There certainly were no *such* rivers then in all that region of the earth's surface which we call the *Coal Region* of the United States.* We must fix our attention upon the great *delta swamps* of the world, if we will hope to understand the ancient coal measures. Lesquereux, who discovered the true origin of coal by studying the peat bogs of the Jura, before 1844, has taught us how to draw the great lesson of it all from the range of Dismal swamps along the Virginia and Carolina sea board.

But the key to the magic lock is after all a *limestone key.* Could we discover the source of our Carboniferous limestone beds, and so work out their varability in character and thickness, so limit their edges geographically, and so define their exact relationship to the coal beds, as to

*No American geologist requires now an argument to disapprove the old theory of *floated coal sediments;* nor such modifications of it as have recently been advocated by Grand' Eury and others, in Europe.

make it plain where and how they were deposited, a world of sunlight would be shed upon the scenery of the Coal ages, now gazed on by us through a haze of absolute time and under a twilight of imperfect information.

In spite of a most assiduous study of the Coal Measurers of Europe and America by all geologists, since Logan published his famous discovery of the *under clay* in 1832, no geologist can even now give an entirely acceptable and complete account of how the limestone beds were created; neither where their carbonate of lime came from; nor why the different lime deposits commenced and stopped, preceded and followed by layers of common mud and sand; nor why each lime deposit reached only so far and no farther in a given direction; here only 1′ to 2′ thick, and yonder, but a few miles distant, 20′, 40′ or 80′ thick; nor why the different lime deposits occupy quite different shapes and extents of area, overlapping each other in all possible directions; nor why some constitute the floors and others the roofs of coal beds; nor why in the body of lime deposits a coal bed sometimes lies, like a foreign body, out of place; nor why some are fossiliferous and others not; some full of broken fragments of animals, and others crowded with nearly or quite perfect forms which apparently lived where they are found; some, fresh water species; others, salt or brackish water species; nor why no leaves of ferns or trunks of trees are to be seen in them.



gion to have borne a resemblance to that expanse of delta which South America now exhibits on the Amazon and Orinoco with their thousand mouths, or, such as India exhibits in its labyrinth of streams and jungles fed by the Ganges and 'Burrampootra, distributing, in seasons of inundation, the siliceous, argillaceous and calcareous détritus of the Andes and Himalya mountains in layers of fine lime shale over the temporarily submerged surface—is there any kind of living organisms at the present day which may suggest an organic concentration of the lime into local beds?

Coral animals are out of the question; for, they require the abundant food and air which ocean waves breaking on reefs can alone provide; nor are there any fossil corals found in the coal measures limestone beds, except in a fragmentary state and brought by water currents, from what distance and from what direction we know not, but apparently from some uncovered sub-Carboniferous land in the west.

The abundance of minute gasteropods or whorled shells in some of the limestone beds, of small bivalve crustaceans and of bryozoan forms of a low order, with numerous spines and teeth of fish, prove that the waters swarmed with life of certain kinds; but the absence of large sea shells may be taken as good evidence for the freshness of the water and the temporary character of its channels and basins. Perhaps the principal role in the process of secreting lime was played by the *bryozoa.** The fact that they

*An important discovery, made by Mr. J. Walther, may throw some light on the matter. There is a class of Mediterranean algae, or sea weeds, the *Nullipores*, which secrete such vast quantities of lime that their organic living cellular tissue amounts to only 5% of the lime bed which they create. They take part in the building of coral reefs; but, in the Gulf of Naples these *lithothamnia* are engaged in making, at various depths, from 100′ to 300′, beds of chalk, or structureless limestone; and at Syracuse, such beds, made by them in Tertiary times, lifted out of water and quarried, exhibit the *lithothamnia* forms *on their weathered surfaces*; but inside seem quite structureless. In the quarry rock Mr. Walther found by analysis that the organic matter was reduced to 0.33%, and the pure white lime rock was quite free from bitumen. These plants grow to the size of a man's fist, the

can only be readily detected on the weathered surfaces, merely shows that their shapes are concealed in the body of the rock by its cement; and that the carbonic acid produced by the oxidation of the animal tissue has effected a general solution of the skeleton lime-mass sufficient to obliterate the traces of its original structure."

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living on the dead, and form extensive beds, interlocking their many stout branches closely; and where the growth fails, common mud deposits take place and keep up the general level. (Science, June 25th., 1886, page 575). The bearing of these facts upon the study of the *Stromatopora* beds of the *Upper Silurian formation No. VI*, and the *Lower Devonian Corniferous formation No. VIIIa* is very interesting.

NOTE.—Fossil plates, Nos. 532 to 595, which follow, were all drawn and prepared by the State Geologist, J. P. Lesley, and will be found figured on a larger scale in many of the separate reports of the Geological Survey.



FOSSIL PLANTS AND SHELLS

OF THE

COAL MEASURES

Plates 532 to 595.

Prepared by
J. P. LESLEY, STATE GEOLOGIST,
From Illustrations in
Reports, P, P2. P3 and P4.





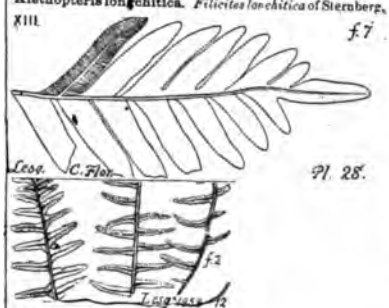
PLATE 532

No. XIII. Fossil plants of the Coal Measures.

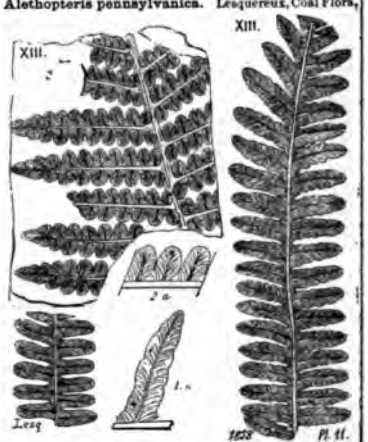
Alethopteris gigas ? Geinitz. Fontaine & White's Flora,



Alethopteris lonchitica. *Filicites lonchitica* of Sternberg,



Alethopteris pennsylvanica. Lesquereux, Coal Flora,



Alethopteris grandifolia. (Newberr



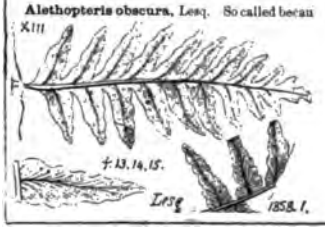
Alethopteris serlii. (*Pecopteris serlii*, Brogniart, 1882,)



Alethopteris nervosa. (*Pecopteris nervo*



Alethopteris obscura, Lesq. So called becau



Alethopteris virginiana. Fontaine & White, Geol. Sur.

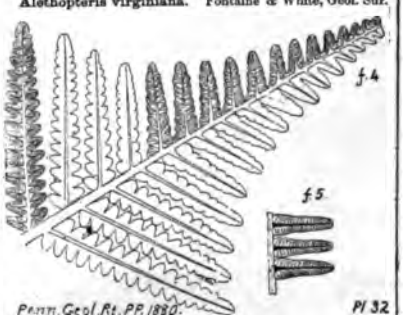
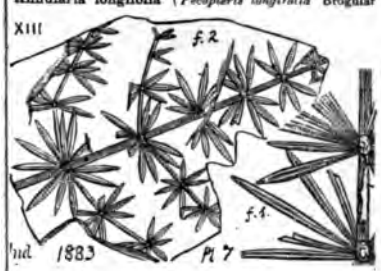


PLATE 533

No XIII Fossil plants of the Coal Measures.

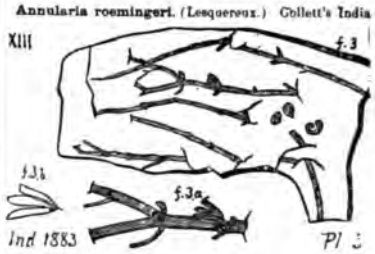
Annularia longifolia (*Pecopteris longifolia* Brogniar



Archæopteris bockshiana ? Geop *Noeggerathia bock*



Annularia roemingeri. (Lesquereux.) Collett's India

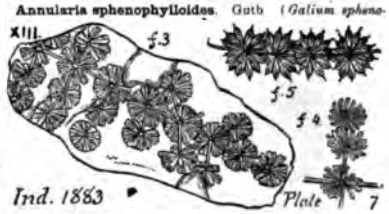




Archæopteris minor. Lesquereux. (*Noegg*



Annularia sphenophylloides. Gutb (*Galium spheno-*



Archæopteris obtusa. (*Noeggerathia obtusa.*) Lesq. Geol.



Pa., 1858, p. 830, fig. 684, *I.T.* Catskill formation, also p. 854.



Asterophyllites. Brogniart. (Branches of Calamite

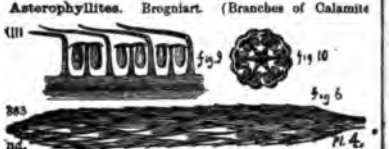


PLATE 534

No. XIII. Fossil plants of the Coal Measures.

Asterophyllites crassicaulis. Lesq.



Asterophyllites fasciculatus. (Lesq.)



Asterophyllites gracilis. (Lesquereux)



Asterophyllites equisetiformis. Brogniart. (*Casuari-*



Asterophycus simplex.



Asterophyllites ovalis.



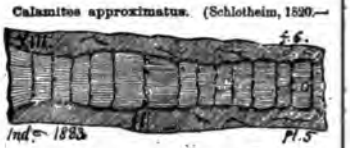
Asterophyllites subleavis. L.



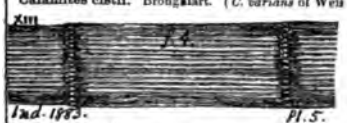
Asterophycus coxii. (Lesquereux;)



Calamites approximatus. (Schlotheim, 1820.—



Calamites cistii. Brongniart. (*C. varians* of Wei



Calamites disjunctus. Lesq.



Calamites cannæformis. (Schlotheim. — Lesq

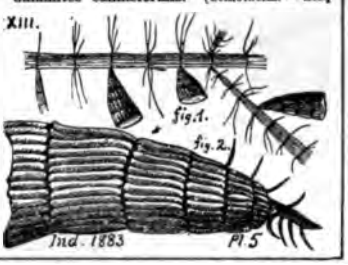
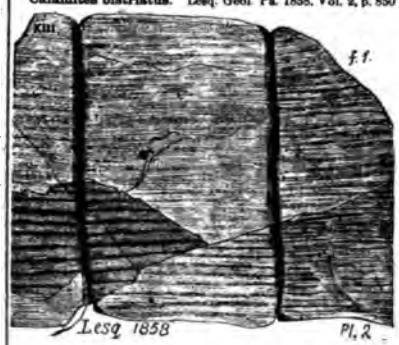




PLATE 535

No. XIII. Fossil plants of the Coal Measures

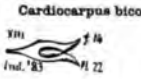
Calamites bistriatus. Lesq. Geol. Pa. 1858. Vol. 2, p. 850



Calamites suckovii.



Cardiocarpus bicornutus.



Cardiocarpus harveyi.



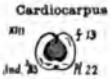
Callipteridium rugosum. (Lesquereux, Coal Flo



Cardiocarpus ingens.



Cardiocarpus (*Samaropsis*) simplex.



Cardiocarpus ovalis.



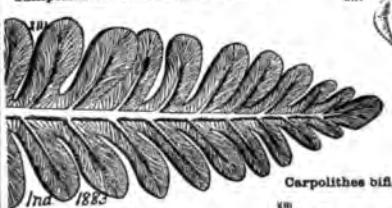
Cardiocarpon plicatum.



Cardiocarpus mammillatus.



Callipteridium sullivanti. (Lesquereux,



Carpolithes arcuatus. (*Rhabdocarpa*



Carpolithes bifidus.



Carpolithes bicuspidatus.



Carpolithes disjunctus.



Callipteris sullivanti. Lesq.



Carpolithes orbicularis.



Carpolithes platimarginatus.



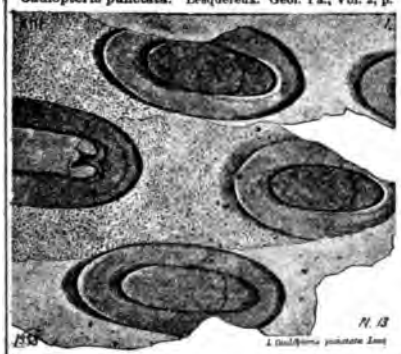
Carpolithes regularis?



PLATE 536

No. XIII. Fossil plants of the Coal Measures.

Caulopteris punctata. Lesquereux. Geol. Pa., Vol. 2, p.



Caulopteris gigantea. Lesquereux



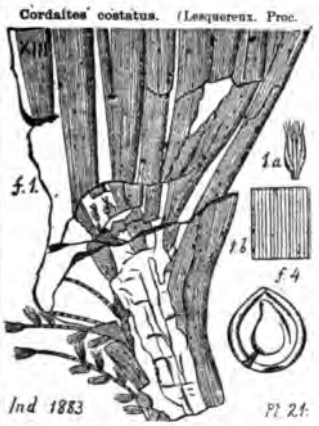
Cordaicarpus apiculatus.



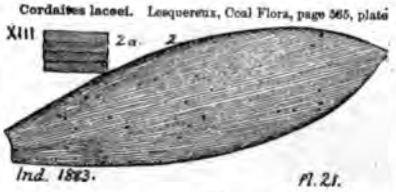
Cordaicarpus gutbieri.



Cordaites costatus. (Lesquereux. Proc.



Cordaites lacoei. Lesquereux, Coal Flora, page 365, plate



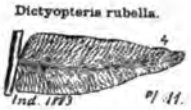
Cordaites serpens; the pit



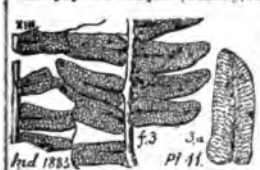
Cremnatopteris pennsylvanica. Lesq. Geol. Pa. II, 868,



Dictyopteris rubella.



Dictyopteris obliqua. (Bunbury, Co



Cyclopteris elegans. (Lesquereux Boston Jour. Sci.



Eremopteris artemisiifolia. (*Sphenopteris artemisi*



Eremopteris? marginata.







PLATE 537

No. XIII. Fossil plants of the Coal Measures.

Halonia flexuosa. (*Ulodendron flexuosum*



Hymenophyllites Hildreti. Lesq. Geol. Pa.



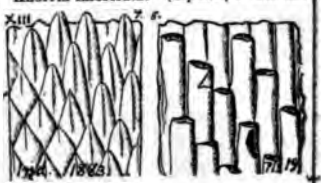
Halonia tuberculata. (Brongu



Hymenophyllites capillaris.



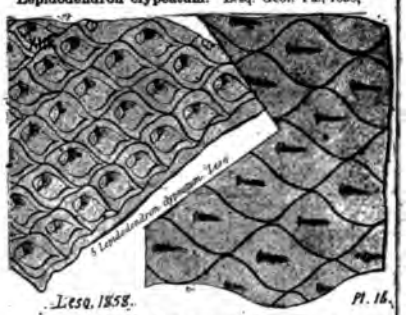
Knorria imbricata. (*Lepidolepis imbricata*



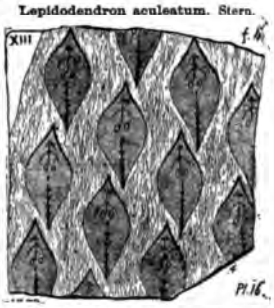
Lepidodendron brittsii



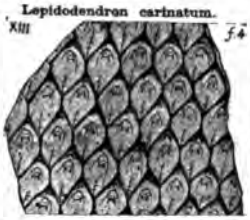
Lepidodendron clypeatum. Lesq. Geol. Pa., 1858,



Lepidodendron aculeatum. Stern.



Lepidodendron carinatum.



Lepidodendron diplotegioides.



Lepidodendron conicum P Lesq. (



Lepidodendron distans. (Lesquere



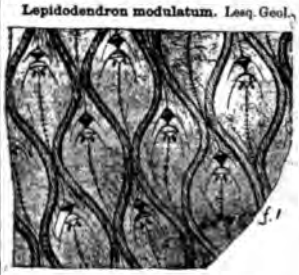
Lepidodendron corrugatum. Daws. Geol Canada, 1873



PLATE 538

No. XIII Fossil plants of the Coal Measures.

Lepidodendron modulatum. Lesq. Geol.



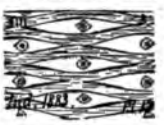
Lepidodendron obtusum. Lesq. Geol. Pa., 1858, p. 87



Lepidodendron sigillarioides.



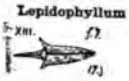
Lepidodendron rimosum.



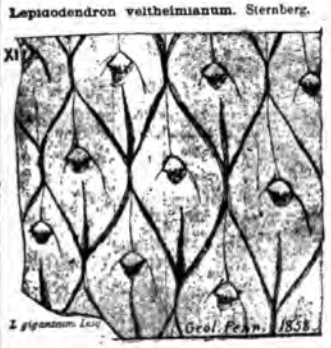
Lepidodendron vestitum. Lesq. Geol. P



Lepidophyllum hastatum.



Lepidodendron veltheimianum. Sternberg.



Lepidophloios macrolepidotus. Goldfuss, Flor. Sarrep



Lepidophyllum brevifolium.



Lepidophyllum affine.



Lepidophyllum acuminatum. Lesq.

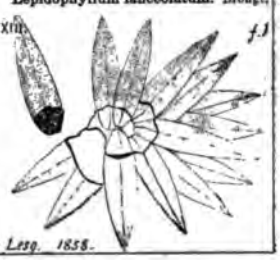


Lepidophyllum plicatum





Lepidophyllum lanceolatum. Brongt.



Lepidophyllum obtusum. Lesq. Geol. Pa., 1858,

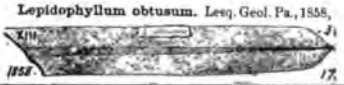




PLATE 539

No XIII. Fossil plants of the Coal Measures.

(*Lepidostrobus mirabilis continued.*)

XIII.



Lepidostrobus oblongifolius. Lesquereux





Lepidostrobus hastatus.

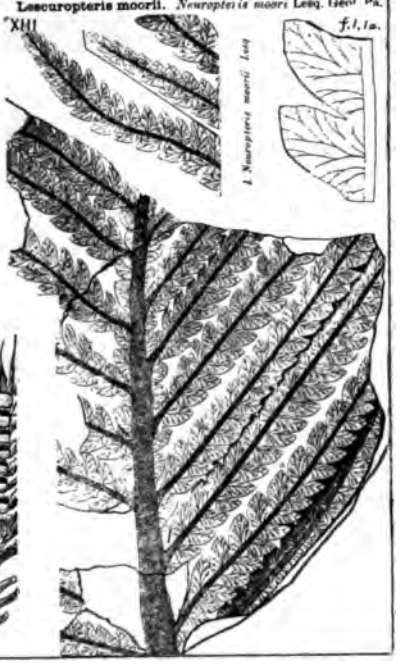


Lepidostrobus ornatus. Lindley & Hutto





Lescuropteris moorii. *Neuropteris moori* Lesq. Geol Pa.



Lycopodiaceæ, called Club Mosses, now living

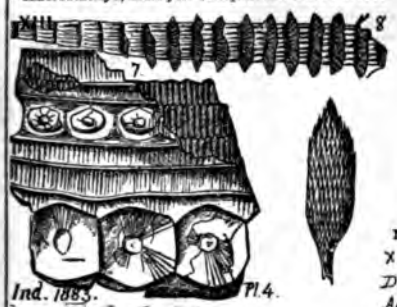




PLATE 540

No. XIII. Fossil plants of the Coal Measures

Macrostachya, Schimper. (Lesquereux's Coal Flora of Pe



Macrostachya (*Asterophyllites*) **aperta**,



Meekella striatocostata. *Plicatula*



Megaphyton magnificum, Dawson. Acad. Geol. 1868,

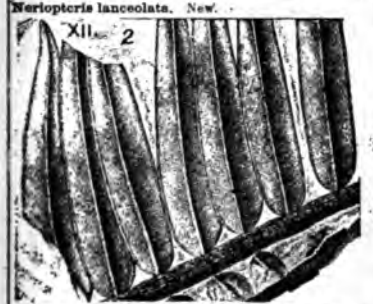
XIII
Dawson. Acadian Geology



Megalopteris, Dawson.



Neriopteris lanceolata. New.



Megaphytum protuberans



Neuropteris adiantites





Neuropteris augustifolia,

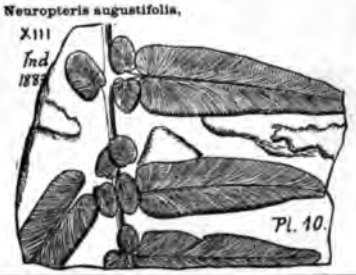




PLATE 541

No. XIII. Fossil plants of the Coal Measures



Neuropteris cyclopteroides.



Neuropteris calloса. (Lesquer



Neuropteris crenulata ?



Neuropteris cordata



Neuropteris delicatula. Lesq.



Neuropteris elrodi.



Neuropteris desorii. Lesq. Geol. Pa. 1858, p. 889, plate





Neuropteris fimbriata.

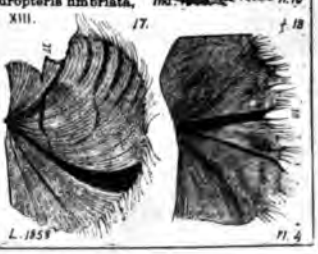


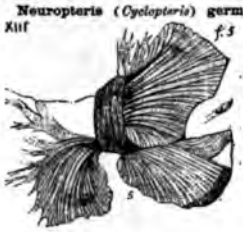
PLATE 542

No. XIII. Fossil plants of the Coal Measures.

Neuropteris dentata. (*Cyclopteris undans,*



Neuropteris (*Cyclopteris*) **germari.**



Neuropteris fissa. Lesq.



Neuropteris gibbosa. (*N. undans,* Lesq

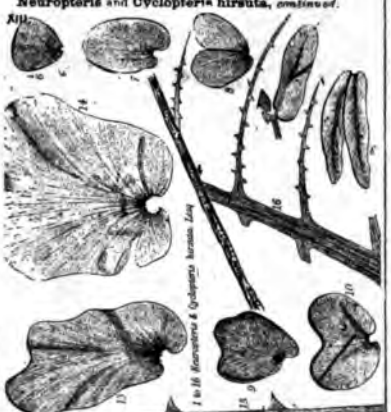




Neuropteris hirsuta.



Neuropteris and **Cyclopteris hirsuta,** *continued.*



Neuropteris (*Cyclopteris*) **laciniata.** Lesq. Geol.

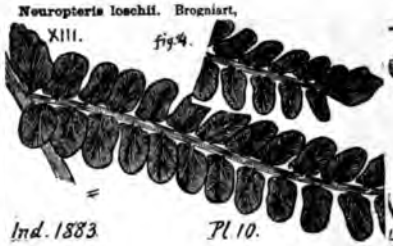


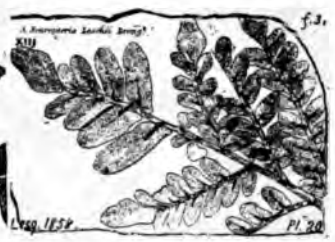


PLATE 543

No. XIII. Fossil plants of the Coal Measures.

Neuropteris loschii. Brogniart,





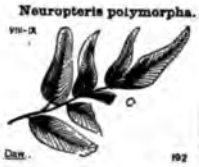
Neuropteris minor (*decorii* ?).



Neuropteris plicata. Sterno.



Neuropteris polymorpha.



Neuropteris rogersi. Lesq.



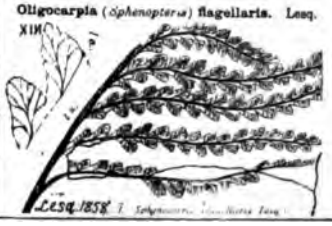
Neuropteris tenuinervis. Lesq. Geol. Pa. 1858.



Neuropteris willersii. (callosa ?) Brgt.



Oligocarpia (*aphenopteris*) **flagellaria.** Lesq.



Odontopteris *affinis.* Lesquereux. Coal Flora of Pa.,

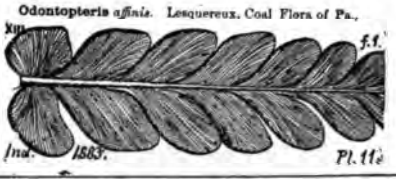
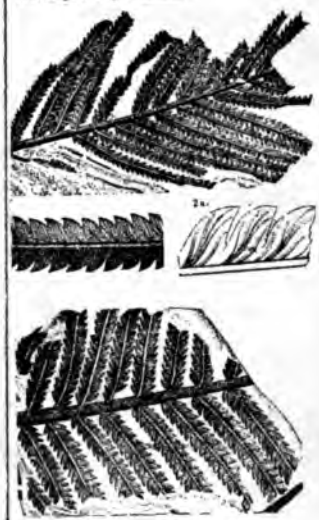


PLATE 544

No. XIII. Fossil plants of the Coal Measures.

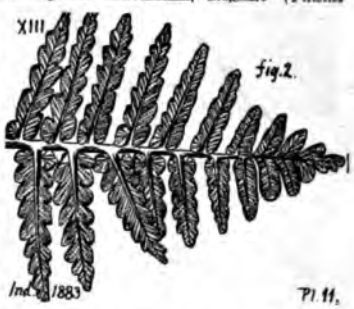
Odontopteris gracillima



Odontopteris neuropteroides



Odontopteris schlotheimii, Brogniart (*Filicites*



XIII



Pl. 11.

Odontopteris squamosa, Lesq. Jour. Bost. N. H. S., VI,



Odontopteris subcuneata.





[redacted]

No. XIII. Fossil plants of the Coal Measures.

Orthogoniopteris clara. *See page 565.*

XII. 1a.



Orthogoniopteris gilberti,

XII-XIII

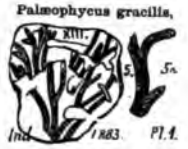
Andrew



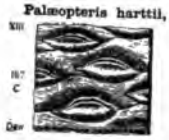
Palæopteris acadica, Dawson.



Palæophycus gracilis,



Palæopteris harttii, Dawson.

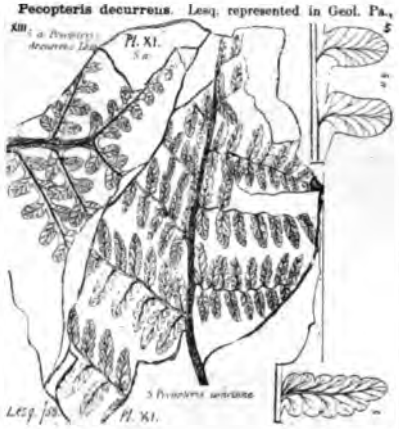


Plant. "Like the primordial frond of a *Platycerium*

XI.



Pecopteris decurrens. Lesq. represented in Geol. Pa.,



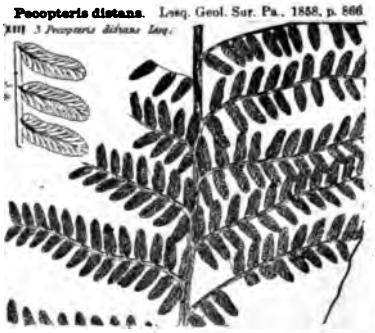
Pecopteris incompleta Lesq. Geo



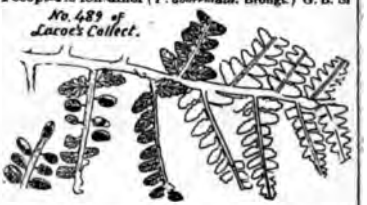
PLATE 546

No. XIII. Fossil plants of the Coal Measures.

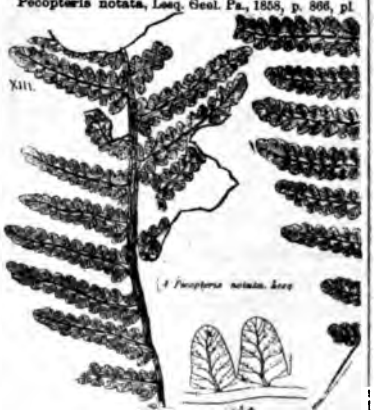
Pecopteris distans. Lesq. Geol. Sur. Pa., 1858, p. 866



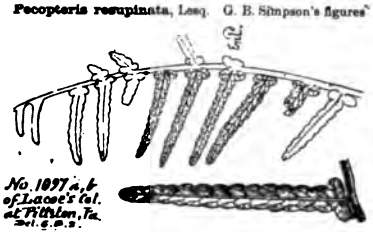
Pecopteris fon.ained (*P. abbreviata.* Brongt.) G. B. Si



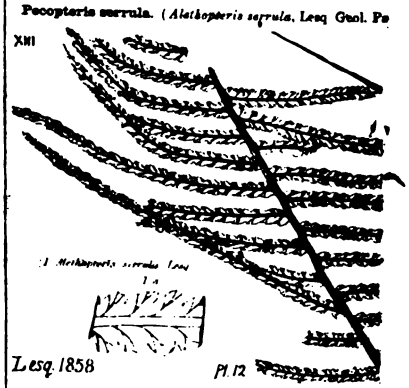
Pecopteris notata, Lesq. Geol. Pa., 1858, p. 866, pl.



Pecopteris recupinata, Lesq. G. B. Simpson's figures



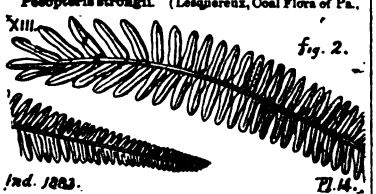
Pecopteris serrula. (*Alethopteris serrula,* Lesq Geol. Pe



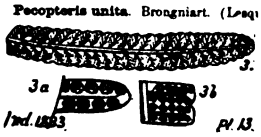
Pecopteris (*Alethopteris*) **serrulata.** Hartt.



Pecopteris strongii. (Lesquereux, Coal Flora of Pa.,



Pecopteris unita. Brongniart. (Lesq



Pecopteris velutina. Les. Geol. Pa. 1858,

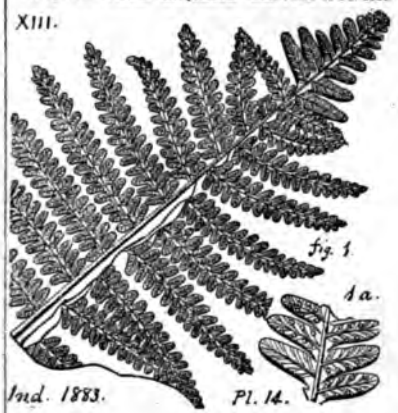


PLATE 547

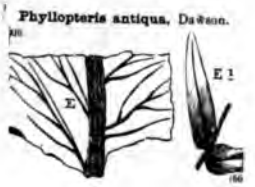
No. XIII. Fossil plants of the Coal Measures

Pecopteris vestita. Lesquereux. Coal Flora of Pa. 1880

XIII.

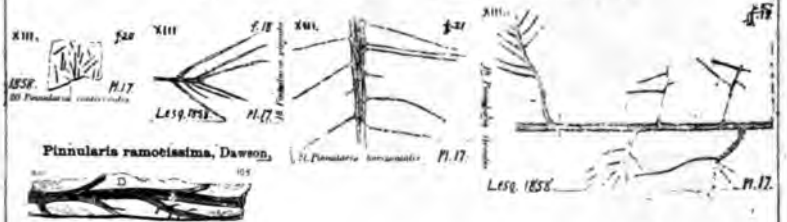


Phyllopteris antiqua. Dawson.



Pinnularia capillacea. (Lindley & Hutton,





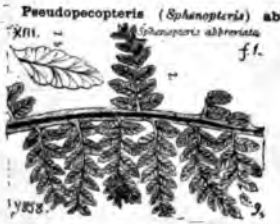
Pinnularia ramotissima, Dawson.

Protoblechnum holdeni. (*Alethopteris holdeni*, Andrews)

XII-XIII.



Pseudopecopteris (*Sphenopteris*) **abbreviata.**



(**Pseudopecopteris anceps.**



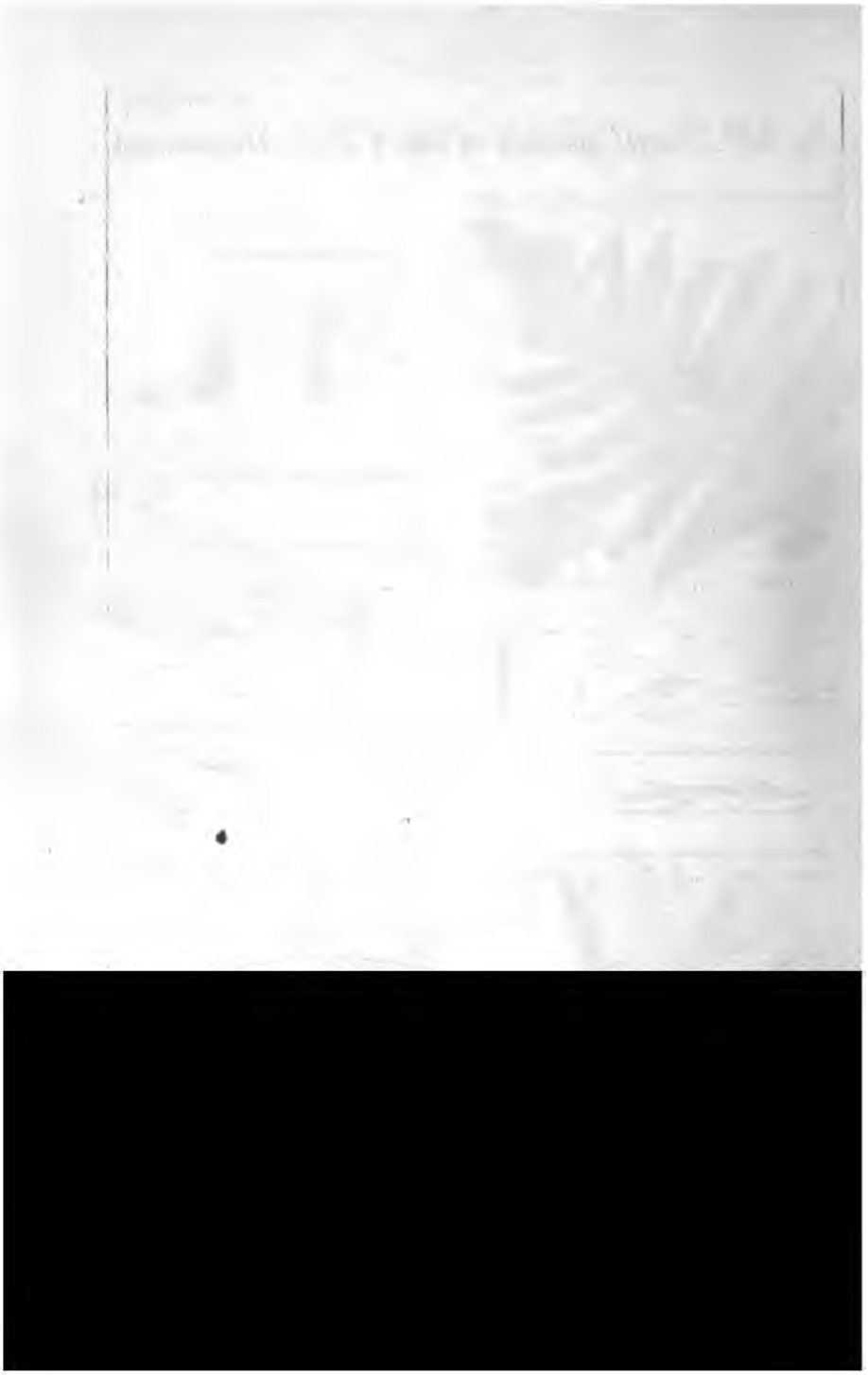
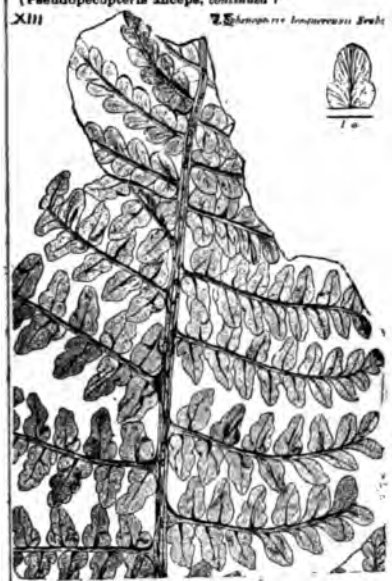


PLATE 548

No. XIII. Fossils plants of the Coal Measures.

(Pseudopecopteris anceps, *continued*)

XIII



Pseudopecopteris (*Sphenopteris*) **decipiens,**

XIII



Lesq. Sphenopteris decipiens Lesq. 18.

Pseudopecopteris macilenta, Ll. and Hutton



No. 351 a of Lacoe's Collect. at Pittston, Pa.

Pseudopecopteris muricata



Ind.

Pseudopecopteris pusilla. *Pecopte*

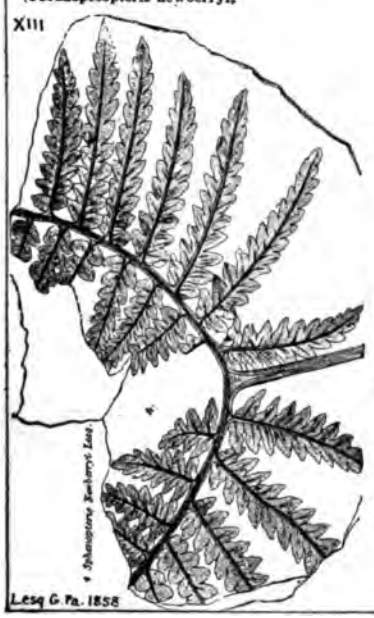
XIII



Pl. 11.

(Pseudopecopteris newberryi,

XIII



Lesq G. Pa. 1858

Rhabdocarpon acuminatum. Newberry. Pal. Ohio, Vol 1

XIII 6 3 8



Plate XLIV.

7



Newb.

Pl. XLIII.

4.



Pal. Ohio. Vol. I.

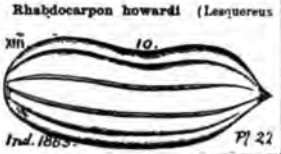
Rhabdocarpon clavatum ?



1826 a Lacoe's Col.

Rhabdocarpon howardi (Lesquereux

XIII 10.



Pl. 22



PLATE 549

No. XIII. Fossil plants of the Coal Measures.

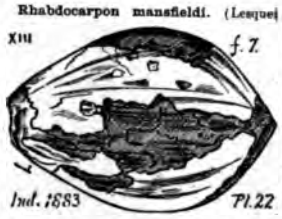
Rhabdocarpon insigne. (Lesquereux. Coal Flora of



Rhabdocarpon jacksonianum, Lesq. G. B. Simpson'



Rhabdocarpon mansfieldi. (Lesquer



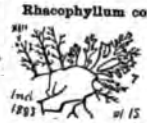
Rhacophyllum adnascens



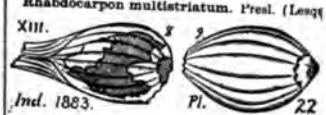
Rhabdocarpon laeve, Newberry,



Rhacophyllum corallinum.



Rhabdocarpon multistriatum. Presl. (Lesq



Rhabdocarpon (unnamed.) Lesq. G. B. Simpson's draw-





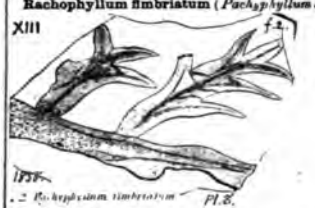
Rhabdocarpon (unnamed.) Lesq. G B. Simpson's draw

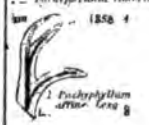


Rhacophyllum hirsutum. (Pachyphyllum hirsutum. Lesq.



Rachophyllum fimbriatum (Pachyphyllum affine.





Rhacophyllum inflatum.



Rhacophyllum lactuca, Stern. (Schizopteris



Rhacophyllum ? scolopendrites.

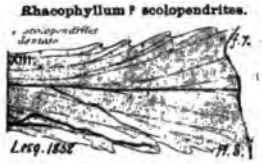


PLATE 550

No. XIII. Fossil plants of the Coal Measures

(*Rhacophyllum truncatum.*



H.D.R. 1858. Pl. 22.

Sigillaria bretonensis. Daw



Sigillaria brownii, Dawson. Acadi

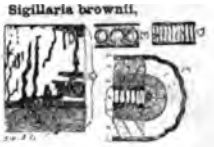


Sigillaria brardii, Brongniart (Hist. Veg. Foss. plate 158;

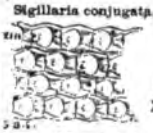


XIII. Ind. 1883. Pl. 20

Sigillaria brownii,



Sigillaria conjugata.

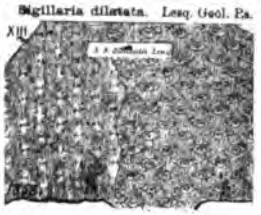


Sigillaria eminens, Dawson.



112 a of Lesley's Collection

Sigillaria dilatata. Lesq. Geol. Pa.



Sigillaria flexa. Lesq. Geol. Pa. 1858.

XIII

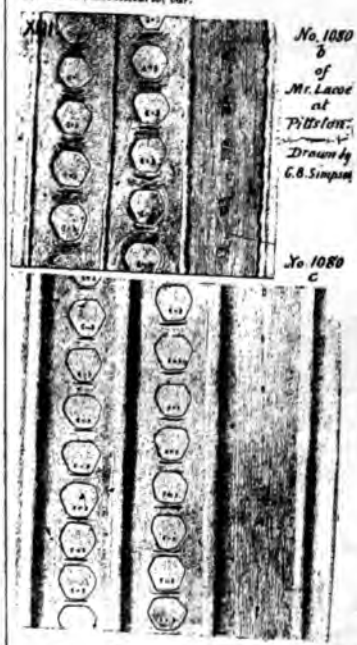


L. 1858. Pl. 15.

PLATE 551

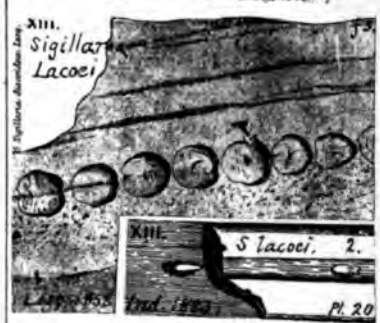
No. XIII. Fossil plants of the Coal Measures.

Sigillaria mammillaris, var.



S. mammillaris, var. latior.





Sigillaria obliqua (*Sigillaria sculpta.*) Lesq. Geol. Pa



Sigillaria marginata. (Lesqu.



Sigillaria ovalis. (Lesqu.



Sigillaria obovata. Lesq. Geol. Pa. 1858.



PLATE 552

No. XIII. Fossil plants of the Coal Measures.

Sigillaria pittstoniana. (Lesq



Sigillaria planicosta, Dawson



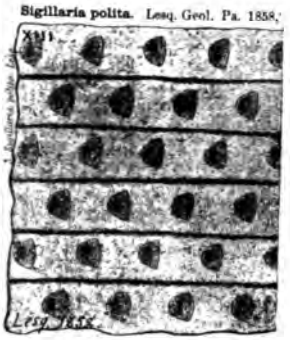
Sigillaria scutellata, Brongt



Sigillaria reticulata. (Lesq



Sigillaria polita. Lesq. Geol. Pa. 1858.



Sigillaria sillimani



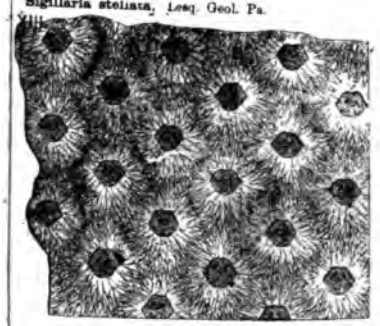
Sigillaria schimperi. Lesq. Geol. Pa



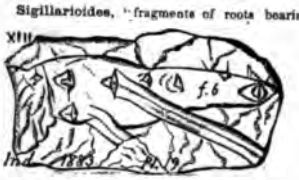
Sigillaria sydensis, Dawson. Acad. Geol. 1868,



Sigillaria stellata, Lesq. Geol. Pa.



Sigillarioides, fragments of roots bearing leaves



Sigillaria tissue. Dawson. Acadian

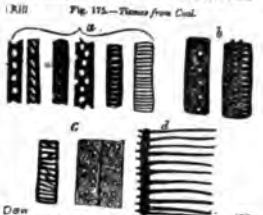
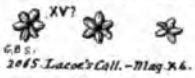


Fig. 175.—*Tissues from Coal.*

(a) Tissue of axis of Sigillaria. (b) Tissue of Ferns. (c) Tissue of Calamites? (d) Scalariform vessel of Lepidodendron.

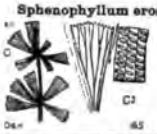
Sorocladus dispersus, Lesq.



Sphenophyllum emarginatum.



Sphenophyllum erosum,



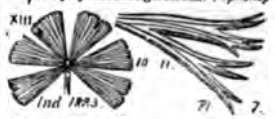
Sphenophyllum fim[illegible]



PLATE 55B

No. XIII. Fossil plants of the Coal Measures.

Sphenophyllum longifolium. (*Sphenop*

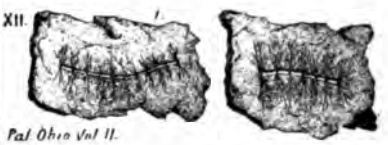


Sphenophyllum oblongifolium. *lo.gifolius*, Germar.

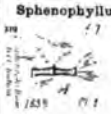


Sphenophyllum schlotheimi, Brongniart.

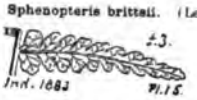




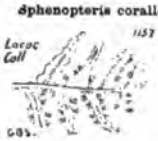
Sphenophyllum trifoliatum, Lesq.



Sphenopteris brittsii. (Lesq



Sphenopteris coralloides, (Gutb.) Lesquereux. G. B. Simpson's drawing (1889) of specimen No. 1157 in Mr. Lacoe's collection at Pittston, Luzerne Co., Pa.

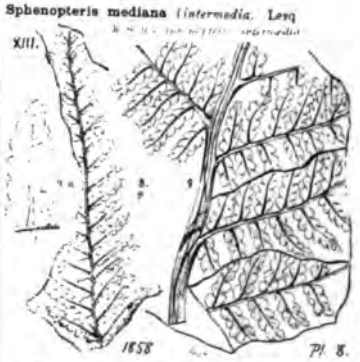


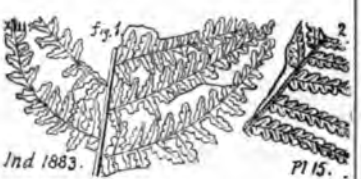
Sphenopteris fuciformis, Lesquereux.





Sphenopteris mediana (*intermedia*, Lesq





Sphenopteris (*Hymenophyllum*) **pendulata**, Lesq. G B Simpson's drawing (1889) of Specimen No. 1129, in Mr. Lacoe's collection at Pittston, Pa., from Dolomite, Alabama. *Coal Measures XIII ?*



Sphenopteris plicata, Lesq.



PLATE 554

No. XIII. Fossil plants of the Coal Measures.

Sphenopteris saliśburyi, Lesquereux



Sporangites papillata, Dawson.



Spirangium appendiculatum, Lesq.



Geol. Ill. Vol. IV.

Stemmatopteris mimica. (Lesq



Stemmatopteris polita. (Lesq



Stemmatopteris cyclostyga. Lesq. G. B. Sim

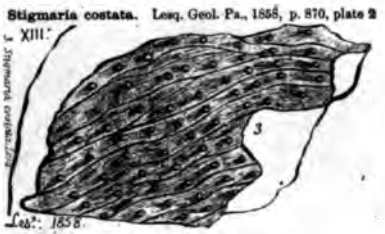


stemmatopteris angustata.

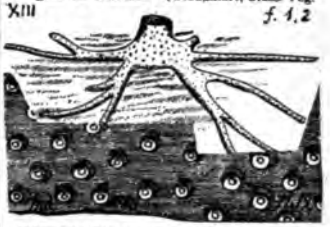


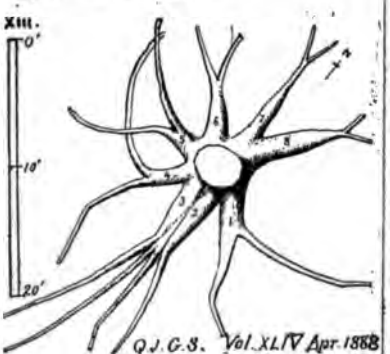


Stigmaria costata. Lesq. Geol. Pa., 1858, p. 870, plate 2



Stigmaria ficoides. (Brongniart, Class. Veg.





Stigmaria ficoides, var. **stellata.** Goe





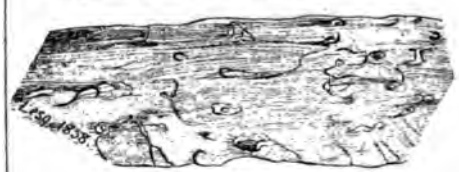
Stigmaria irregularis. Lesq



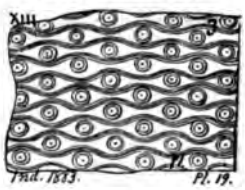
PLATE 556

No. XIII. Fossil plants of the Coal Measures.

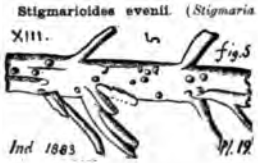
Stigmaria (*Ficoides, var.*) radicans.



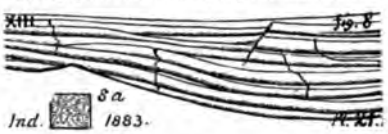
Stigmaria undulata; Goep.



Stigmarioides evenii. (*Stigmaria*



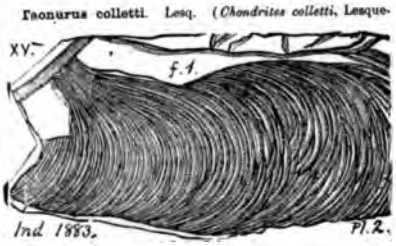
Tæniophyllum decurrens. (Lesq., Proc. Amer. Phil. Soc



Tæniopteris smithii. (Lesqu



Taonurus colletti. Lesq. (*Chondrites colletti*, Lesque-



Trigonocarpon ambiguum.



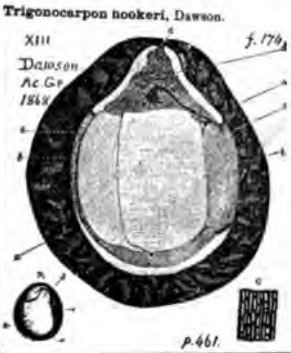
Taonurus marginatus. Lesq.



Trigonocarpon bertholletiforme, Foster, Ann. of Science



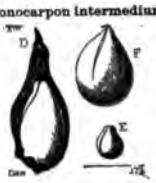
Trigonocarpon nuckeri, Dawson.



Trigonocarpon dawsii. L.



Trigonocarpon intermediun.



Trigonocarpon magnum, Newberry.

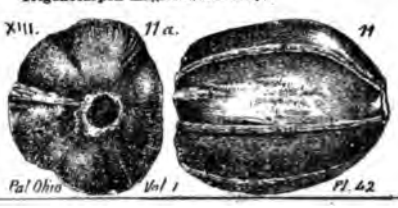
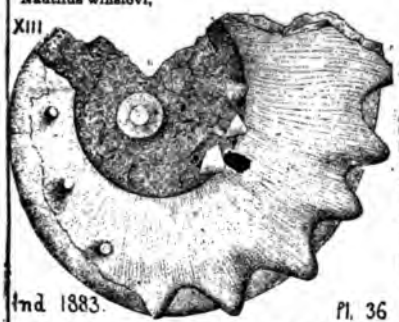


PLATE 565

No. XIII. Fossil shells of the Coal Measures.

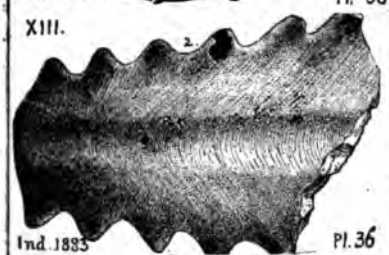
Nautilus winslovi,

XIII



Ind. 1883. Pl. 36

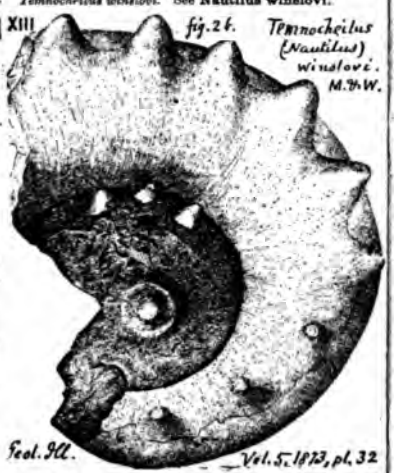
XIII.



Ind. 1883 Pl. 36

Temnocheilus winslovi. See **Nautilus winslovi.**

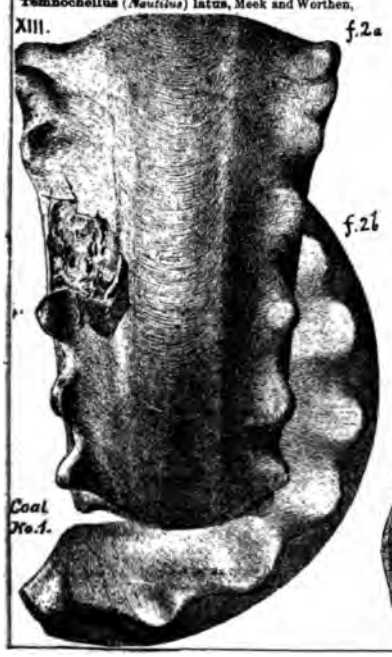
XIII fig. 2 b. Temnocheilus (Nautilus) winslovi. M.P.W.



Geol. Mo. Vol. 5. 1873, pl. 32

Temnocheilus (*Nautilus*) latus, Meek and Worthen,

XIII. f. 2a



f. 2b

Coal No. 1.

Allorisma subcuneata. (Meek & Hay

XIII.

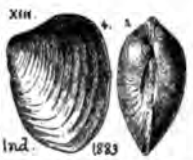


Ind. 1883 Pl. 31.

Anthracosia (Anthracomya ?) **bradorica.**



XIII



Ind. 1883

Grammysia

XIII



Eumicrotus hawni.

XIII Pl. 30



Ind. 1883

PLATE 566

No. XIII. Fossil shells of the Coal Measures.

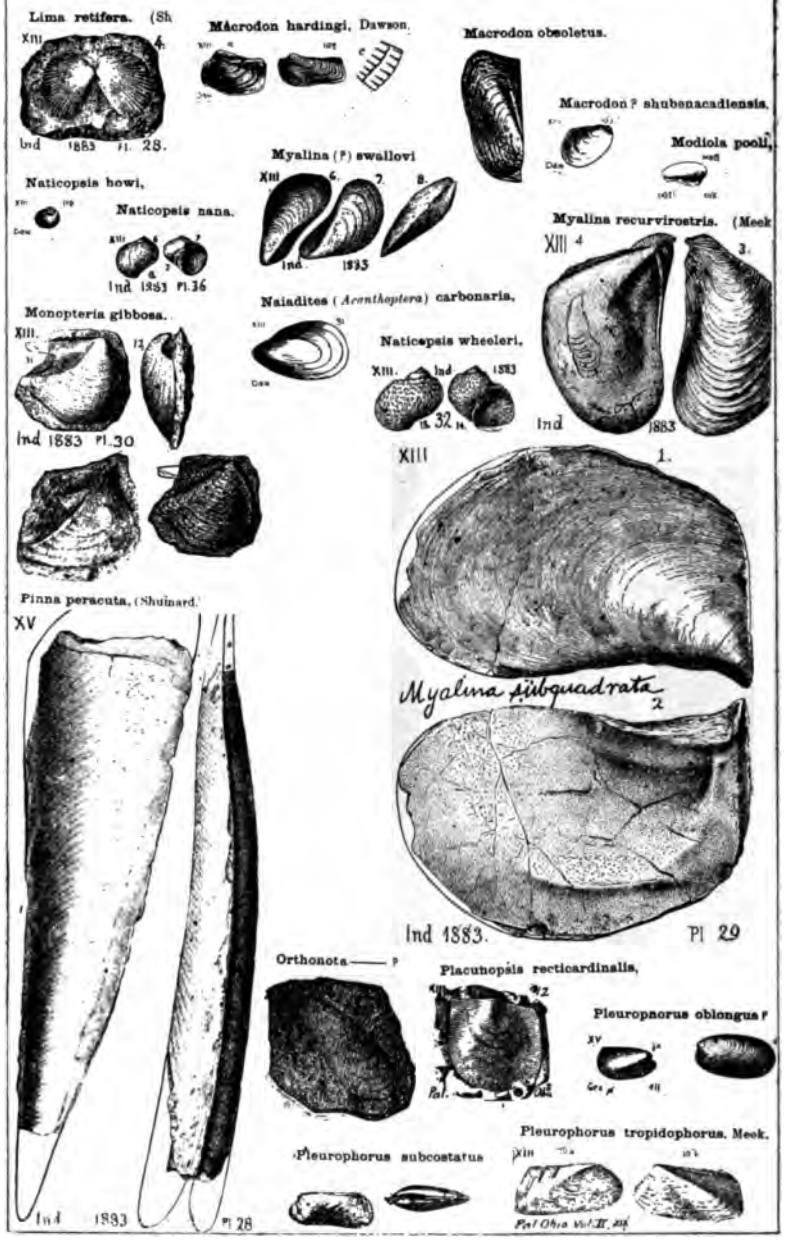


PLATE 567

No. XIII. Fossil shells of the Coal Measures

Placunopsis carbonaria, Meek and Worthen Proc. Chi.



Pseudomonotis (*Eumicrotus*) hawni, Meek and Hayden



Posidonomya fracta,



Pleurophorus? angulatus,



Pteronites gayensis,



Schizodus curtus, Meek and W



Schizodus (*Prisconia*), perelegans



Schizodus amplus. Meek & Worthen.



Schizodus rossicus, De Verneuil, Geo. Russ. 1845; M.



Schizodus cuneatus? Meek, Pal. Ohio,



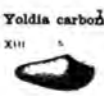
Schizodus wheeleri. (*Cypricardia wheeleri*, Swallo

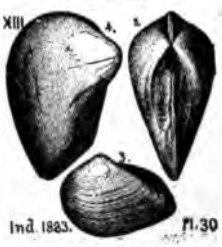


Solenomya? anodontoides,



Yoldia carbonaria,





Yoldia stevensoni, Meek



Solenomya soleniformis, Cox, Geol. Si



Streblopteria? tenuilineata.



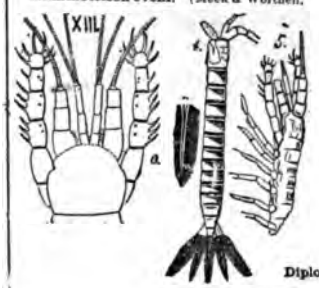
Solenomya radiata (*Solemya radiata*, M



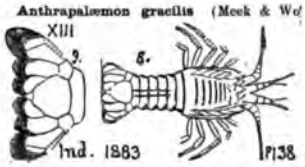
PLATE 568

No. XIII Crabs and Flies of the Coal ages.

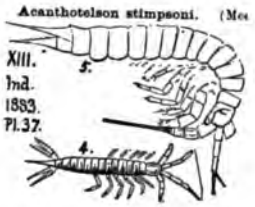
Acanthotelson eveni. (Meek & Worthen.



Anthrapalæmon gracilis (Meek & Wo



Acanthotelson stimpsoni. (Mee



Diplostylus dawsoni



Carestotes lapidea.



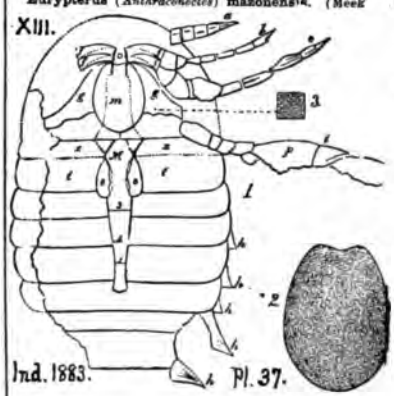
Mylacris anthracophilum.



Eurypterus mansfieldi. (*Dolichopterus*



Eurypterus (*Anthraconectes*) mazonensis. (Meek



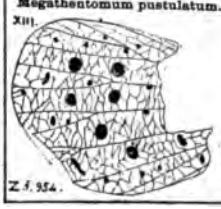
Dithyrocaris carbonarius.



Eoscorpius carbonarius. Mee



Megathentomum pustulatum.



Mylacris pennsylvanicum



Mylacris mansfieldi. Scudder.

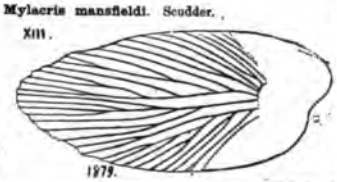


PLATE 569

No. XIII. Trilobites & Insects of the Coal ages.

Phillipsia (*Griffithoides?*) sangamonensis. (Meek

Euproops danæ. (*Bellin*





Phillipsia howi,



Phillipsia (*Griffithoides?*) scitula.





Euproops colletti. White. Colle



Arthrolycosa antiqua. Harger.



Amynilespes wortheni.



Lithomilacris angustum, Scudder





Gerablattina balteata.



Genentomum validum. Scu



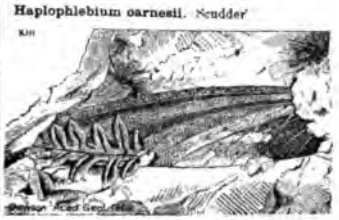
Euphoberia armigera. Me



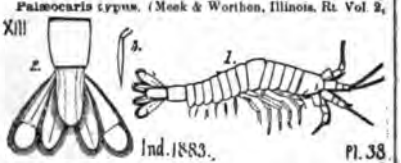
Necymylacris lacoanum Scudder, Mem. Bo



Haplophlebium carnesii. Scudder



Palæocaris typus. (Meek & Worthen, Illinois, Rt. Vol. 2,



anthrax. Meek & Worthen



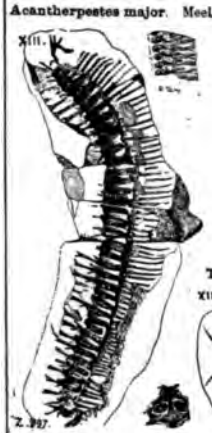
Paolia vetusta. Smith. A dragon fly's wing



PLATE 57o

No. XIII. Insects and Fishes of the Coal ages.

Acantherpestes major. Meel



Phthanocerus occidentalis, Scud



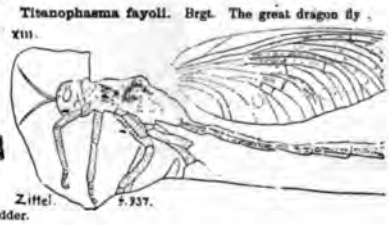
Proteticus infernus. Scud



Trichiulus villosus. Scudder.



Titanophasma fayoli. Brgt. The great dragon fly.



Xylobius sigillariæ, Daw



Xylobius mazonus, Scudder.



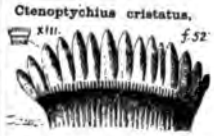
Titanophasma fay



Baphites planiceps. Owen, Proc. Geol. Soc., Lond.,



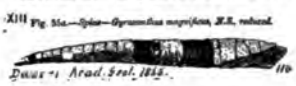
Ctenoptychius cristatus,



Gyracanthus duplicatus, Dawson, Acad. Geol., 1868, p.



Gyracanthus magnificus, Dawson, Acad.



Cochliodus contortus. (Agas.



Conchodus plicatus,



Diplodus *teeth*



a Ctenacanthus spine.



Palæoniscus peltigerus, Newberry. Pal. Ohio. Vol. 1





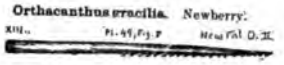
PLATE 571

No. XIII. Fish teeth in the Coal Measures.

Orthacanthus arcuatus. Newberry



Orthacanthus gracilis. Newberry.



Peltodus transversus.



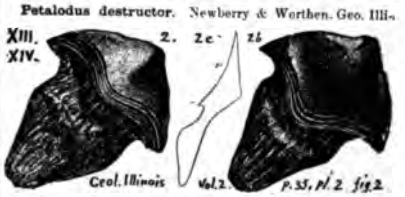
Orthopleurodus carbonarius. (*Deltodus.*



Petalodus alleghaniensis. Leidy.



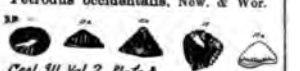
Petalodus destructor. Newberry & Worthen. Geo. Illi.



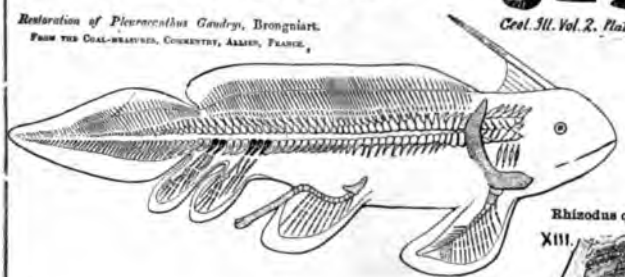
Petalorhynchus (*Petalodus*) **striatus.**



Petrodus occidentalis. New. & Wor.



Restoration of Pleuracanthus Gaudry, Brongniart.
FROM THE COAL-MEASURES, COMMENTRY, ALLIER, FRANCE.



Psammodus



Rhizodus quadratus, Newbe



Poecilodus carbonarius. St. John & Worthen, Geo. Sur



Polyrhizodus carbonarius. St. John & Worthen,





Rhizodus lancifer. Newberry



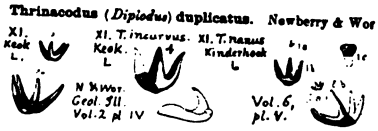
Sandalodus carbonarius, Newberry



PLATE 572.

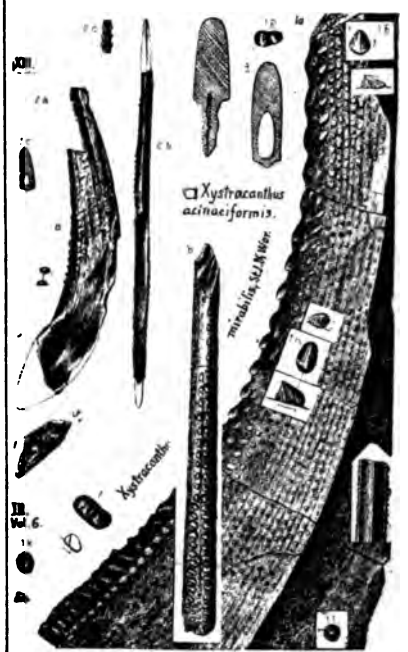
No. XIII. Fishes & Reptiles in the Coal rocks

Thrinacodus (*Diplodus*) duplicatus. Newberry & Wor



Xystracanthus (*Drepacanthus*) anceps,







Dendrerpeton acadianum. Owen,



Dendrerpeton oweni. Dawson, Acadian Geolo



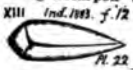
Eosaurus acadianus. Marsh, Canadian



PLATE 557

No. XIII. Fossil plants of the Coal Measures.

Trigonocarpon subcylindricum.



Triphyll pteris chesthami,



Trigonocarpon multicarinatum.



Sigillariostrobus (unnamed). G. B. Simpson's drawing



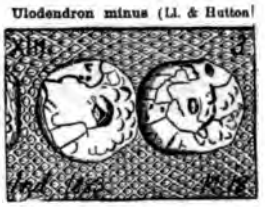
Trigonocarpon ornatum, Newb.



Ulodendron elongatum. (St. Flor



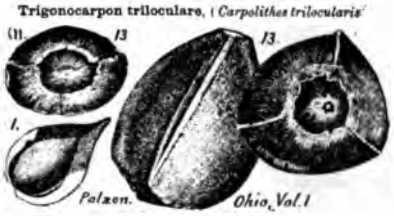
Ulodendron minus (Ll. & Hutton)



Volkmannia fertilis. (Lesqu



Trigonocarpon triloculare, (*Carpolithes trilocularis*



Whittleseya elegans. (Newberry)



Trigonocarpon; *group of seeds.* Newberry.



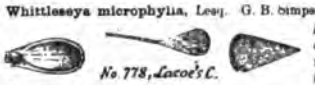
Volkmannia brevistachys, Lesq.



Trigonocarpon tricuspidatum, Newb.



Whittleseya microphylla, Lesq. G. B. Simpson's drawing (1889) of specimens 778, in Mr. Lacoe's collection at Pittston, Pa.



No. XIII. Fossil crinoids in the Coal Measures.

Stictopora carbonaria. (*Ptilodictya carb*



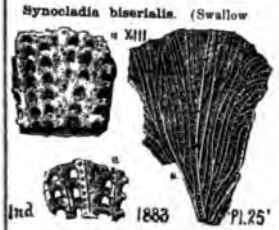
Stenopora exilis (*Ceriopora spongites*, Daw.)



Stictopora serrata. (*Ptilod*



Synocladia biserialis. (Swallow



Synocladia virgulacea, var. **biserialis,** Swallow.





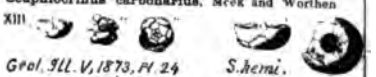
Pterotocrinus (*Asterocrinus*) **coronarius,** Lyon.



(Pentremites obesus. *See p. 620.*)



Scaphiocrinus carbonarius, Meek and Worthen



Strotocrinus (*Actinocrinus*) **regalis,**





Zeacrinus (*Hydreionocrinus?*) **acanthophorus.** Meek





Zeacrinus? **crassus.** (*Cyathocrinus crassus*, Meek an



Geol. Ky. Vol. 3. Plate 2

Lyon.

PLATE 559

No. XIII. Fossil shells of the Coal Measures.

Axophyllum rude. (Whit



Campophyllum torquium (



Lonhophyllum (*Streptelasma*) proliferum.



Michelinia eugenea, White.



Zaphrentis gibsoni. White.



Zaphrentis spinulifera, Hall, Geol. Sur. Iowa.





Athyris subtilita, (Hall, 1852, Stansbury's Expedition



Athyris subquadrata.



Aviculopecten interlineatus.





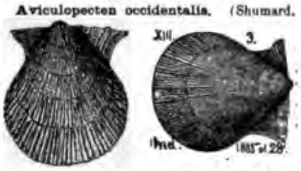
Chonetes verneuiliana.



Aviculopecten carboniferus (



Aviculopecten occidentalis. (Shumard.



Aviculopecten winchelli. (Meek. Ohi





Fusulina cylindrica.



Hemipronites crassus. (*Orthisina crassa*,

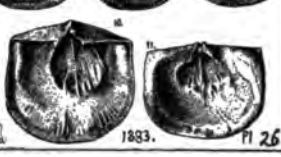


Discina nitida.



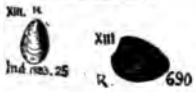
Discina convexa. (Shumard.





No. XIII. Fossil shells of the Coal Measures.

Lingula umbonata,



Nuculana arata.



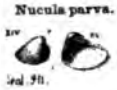
Nuculana bellistriata.



Nucula ventricosa.



Nucula parva.



Orthis pecosii, Marcou.



Orthis resupinoides, Cox, Geol. Sur. Ky., Vol. 3, 1857.



Plicatula (now **Meekella**) striatocostata



Productus cora, d'Orbigny.





Productus cora. (*Productus prattenianus,* Norwood.



Productus nebrascensis Owen, Wisconsin Report, 1



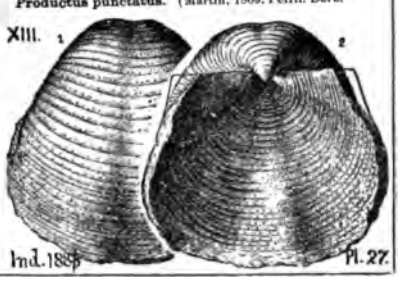


Productus costatus. Sowerby's English species.





Productus punctatus. (Martin, 1809. Petrif. Derb.



Productus longispinus.



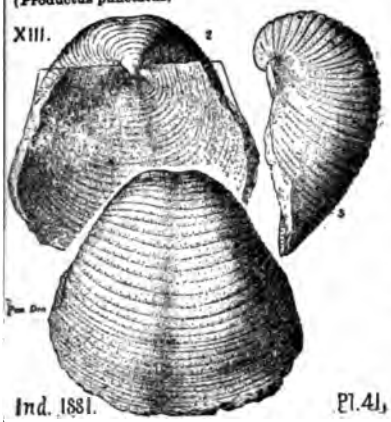
Productus muricatus



PLATE 561

No. XIII. Fossil shells of the Coal Measures.

(Productus punctatus,



Rhynchonella acadiensis, Davidson



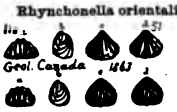
Rhynchonella uta. (*Terebratula*



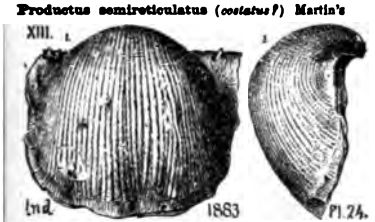
Rhynchonella dawsoniana, Davidson.



Rhynchonella orientalis, Billings.



Productus semireticulatus (*costatus?*) Martin's



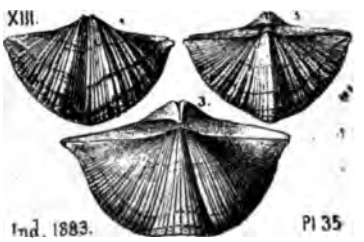




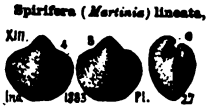
Spirifera acuticostata, DeKoninck.



Spirifera camerata. (Morton,



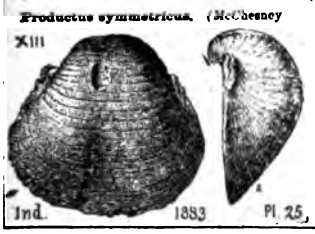
Spirifera (*Martinia*) lineata, Martin.



Spirifera falconensis, Worthen.



Productus symmetricus. (McChesney



Spirifera (Martinia) planoconvexa,



Spirifera ——a Rogers,



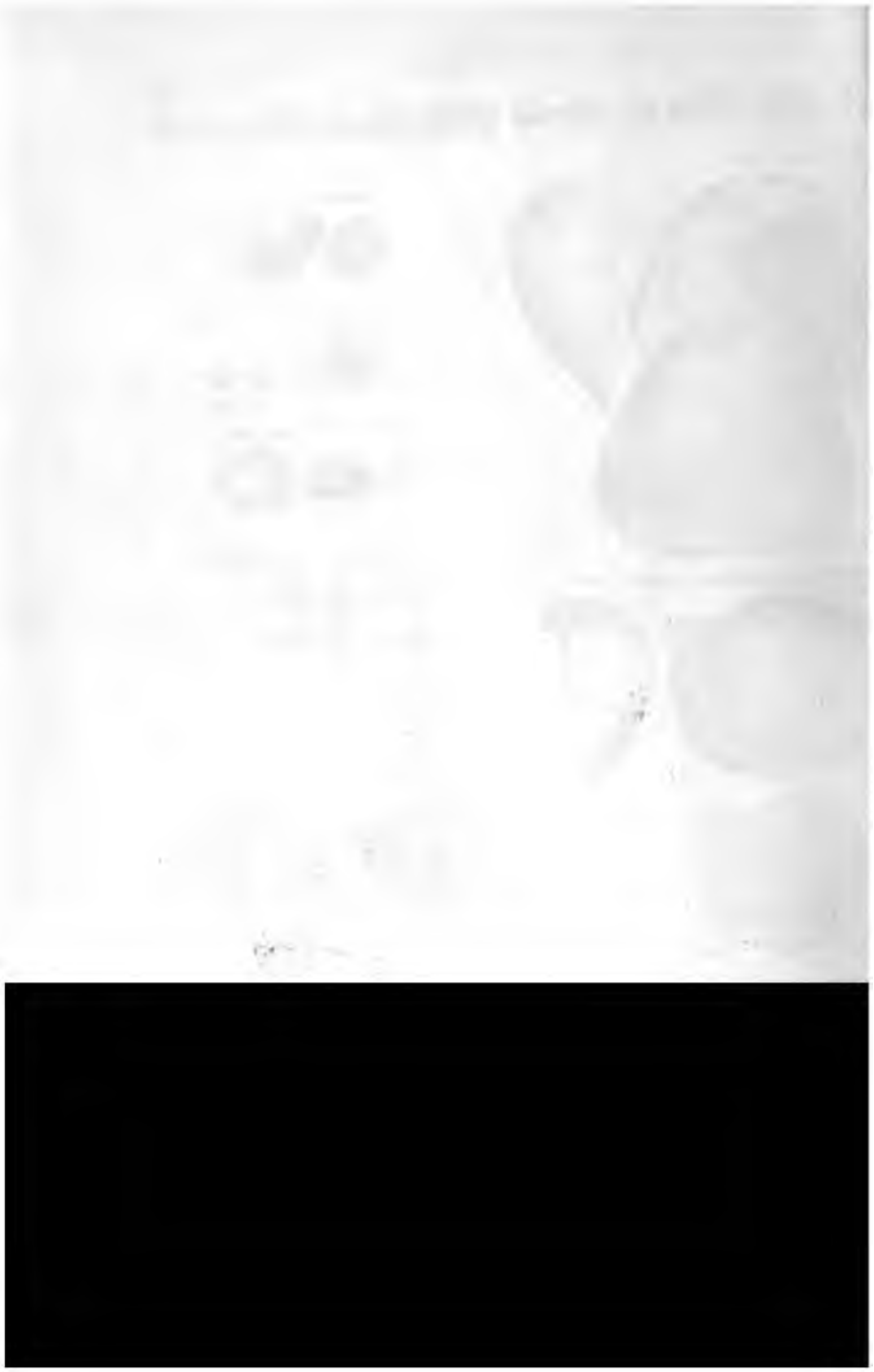


PLATE 562

No. XIII. Fossil shells of the Coal Measures.

Spirifera (subgenus Trigonotreta) opima, Hall.



Spiriferina cristata,



Spiriferina kentuckensis.



Syntrielasma hemiplicatum. (*Spirifer hemiplicatus*,



Streptorhynchus crenistrium



Strophomena analoga.



Terebratula bovidens, Morton,



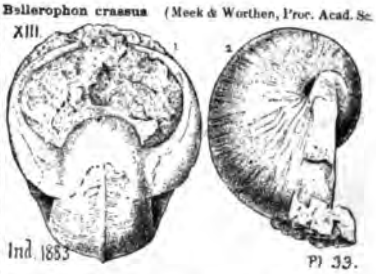
Bellerophon carbonarius. (Cox,



Euomphalus rugosus.



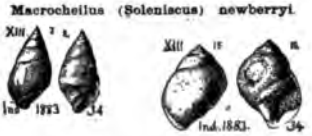
Bellerophon crassus (Meek & Worthen, Proc. Acad. Sc.



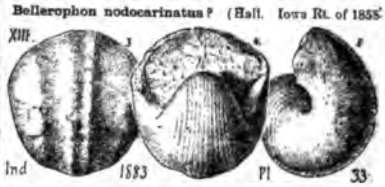
Conulus priscus. Carpenter



Macrocheilus (Soleniscus) newberryi.



Bellerophon nodocarinatus? (Hall. Iowa Rt. of 1855



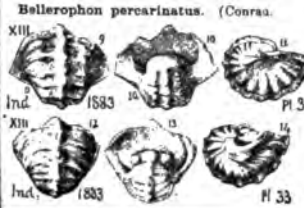
Macrocheilus (*Soleniscus*) paludinaeformis



Macrocheilus primigenius. Conrad.



Bellerophon percarinatus. (Conrad.



Macrocheilus (*Soleniscus*) texanus,



Macrocheilus (*Soleniscus*) ventricosus,



Murchisonia gypsea,



Loxonema acutulum.





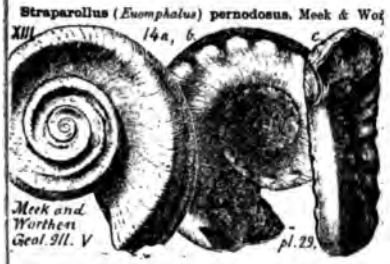
PLATE 563

No. XIII. Fossil shells of the Coal Measures



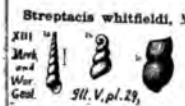
PLATE 564

No. XIII. Fossil shells of the Coal Measures.









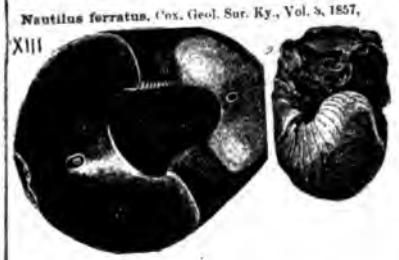




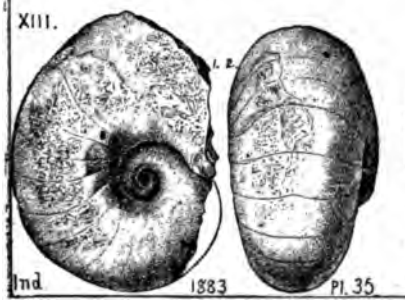


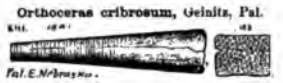












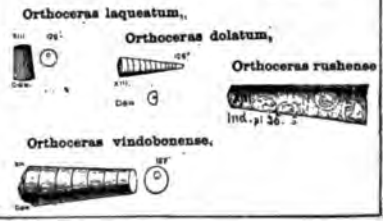


PLATE 573

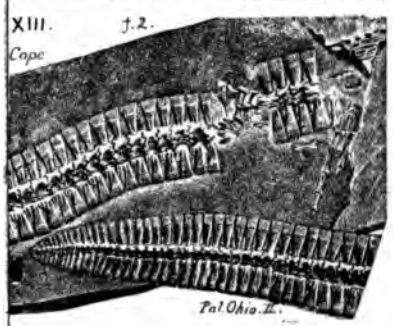
No. XII. Fossil Reptiles of the Coal age.

Œstocephalus remex. (*Sauropleura remex*, Cope, .



Œstocephalus remex, Cope.

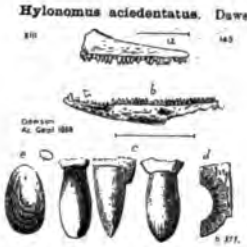




Hylonomus wymani, Dawson. Acadian Geology, p.



Hylonomus aciedentatus. Dawso



Hylonomus lyelli, Dawson, Acadian Geology, 1868.



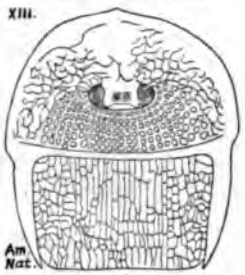
PLATE 574.

No. XIII. Fossil reptiles of the Coal Measures

Œstocephalus rectidens, Cope.



Mycterops ordinatus, Cope.



Hylerpeton dawsoni. Owen. Dawson's



Phlegethontia linearis, Cope Trans. Amer. Philos. Soc

Pal Ohio, Vol. 2. pl 43.

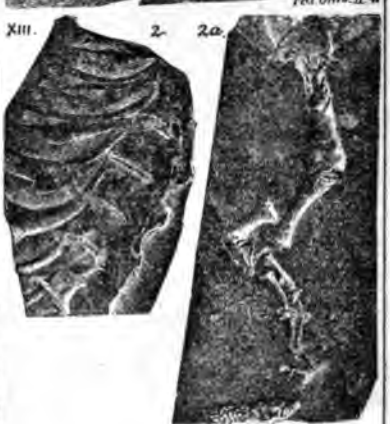
fig. 2.

f. 3.



Pleuroptyx clavatus, Cope, Pal. Ohio. Vol. 2, 1875.





Pelion lyelli, (*Ranicea lyelli*, Wyman,

XIII+





Ptyonius pectinatus,





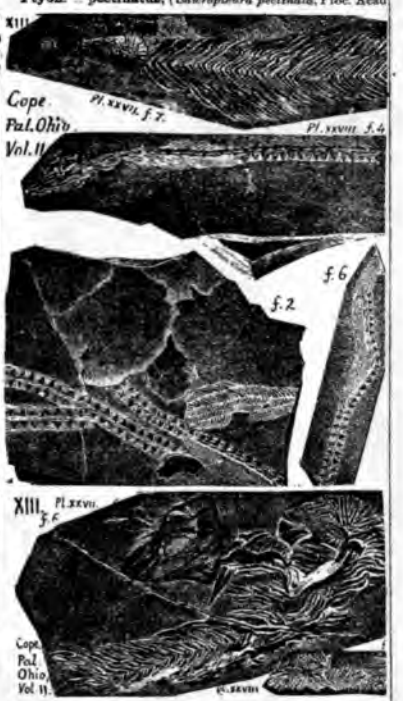
PLATE 575

No. XIII. Fossil reptiles of the Coal age.

Ptyonius pectinatus.



Ptyonius pectinatus, (*Saeropleura pectinata*, Proc. Acad.



Ptyonius nummifer, Cope, Pal. Ohio, Vol. 2, 1875.



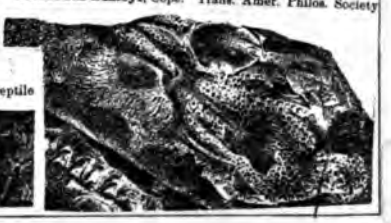
Thyrsidium fasciculare, Cope. Pal. Ohio.



Ptyonius ? serrula. Cope (*Oestocephalus*, Proc. A. P. S.



Tuditanus huxleyi, Cope. Trans. Amer. Philos. Society





A Stegocephalian reptile



PLATE 57G.

No. XIII. Reptile bones and tracks. Coal age.

Sauropleura newberryi.

XIII

f. 2.

Pl. XXXVII

f. 3.

Cope. Pal. Ohio

Sauropleura digitata, Cope.

XIII.



Cope. Pal. Ohio 1875. Vol. II.

Tuditanus longipes, Cope.



XIII.



Pal. Ohio. II

Tuditanus radiatus, Cope.

XIII. 1. 3.



Pal. Ohio Vol. II Pl. XXIV

XIII.

Cope.

Pal. Ohio.

Vol. II



Tuditanus brevirostris, Cope.

XIII

f. 3.



Pal. Ohio, Vol. II.

Sauropus sydnensis. Dawson.



Rusichnites carbonarius.

XIII XII

Dawn



Ptyonius? Side view of the head

3.

Pal. Ohio II. Pl. XXIV.



PLATE 57 (1)

XV-XVI. Waynesburg and higher coals.

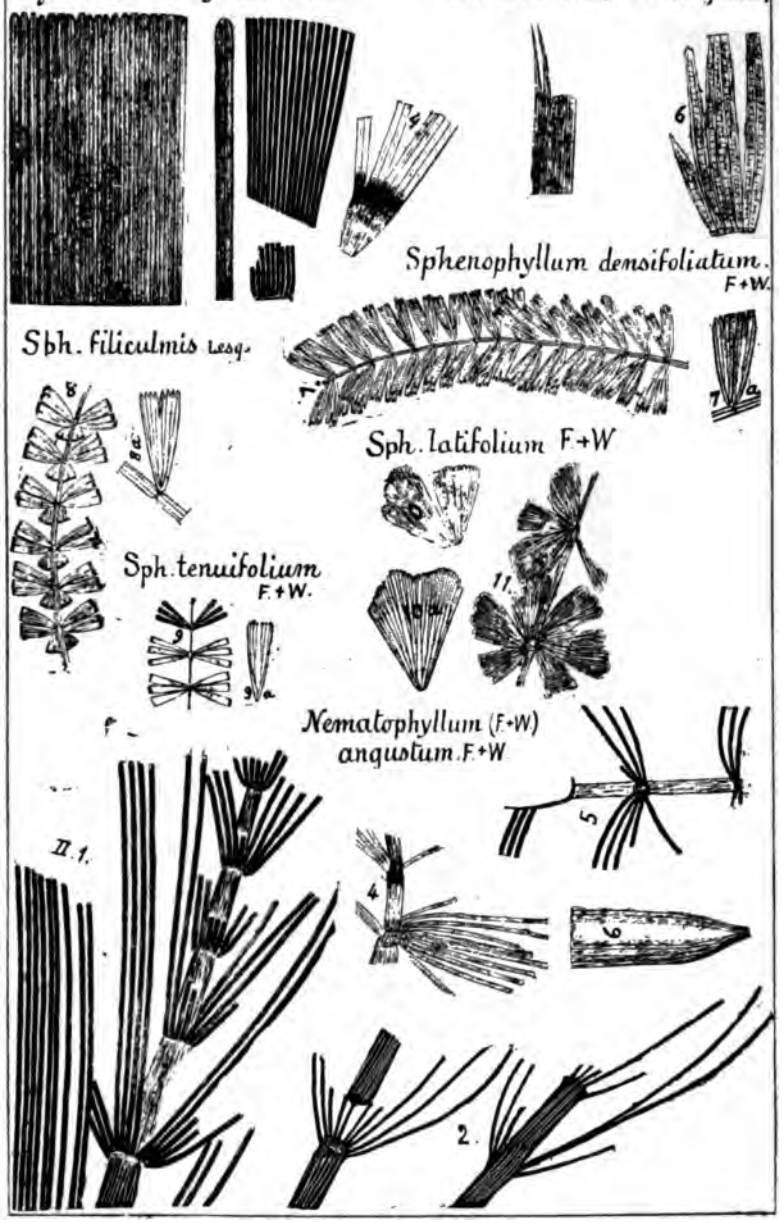


PLATE 578

XV-XVI. Waynesburg and higher coal beds

Sphenopteris acrocarpa. F+W.





Sphenopteris minutisecta. F+W.



Sph foliosa. F. and W.

Sphenopteris coriacea. F+W



Sph dentata. F+W.



XV-XVI. Waynesburg and higher coal beds

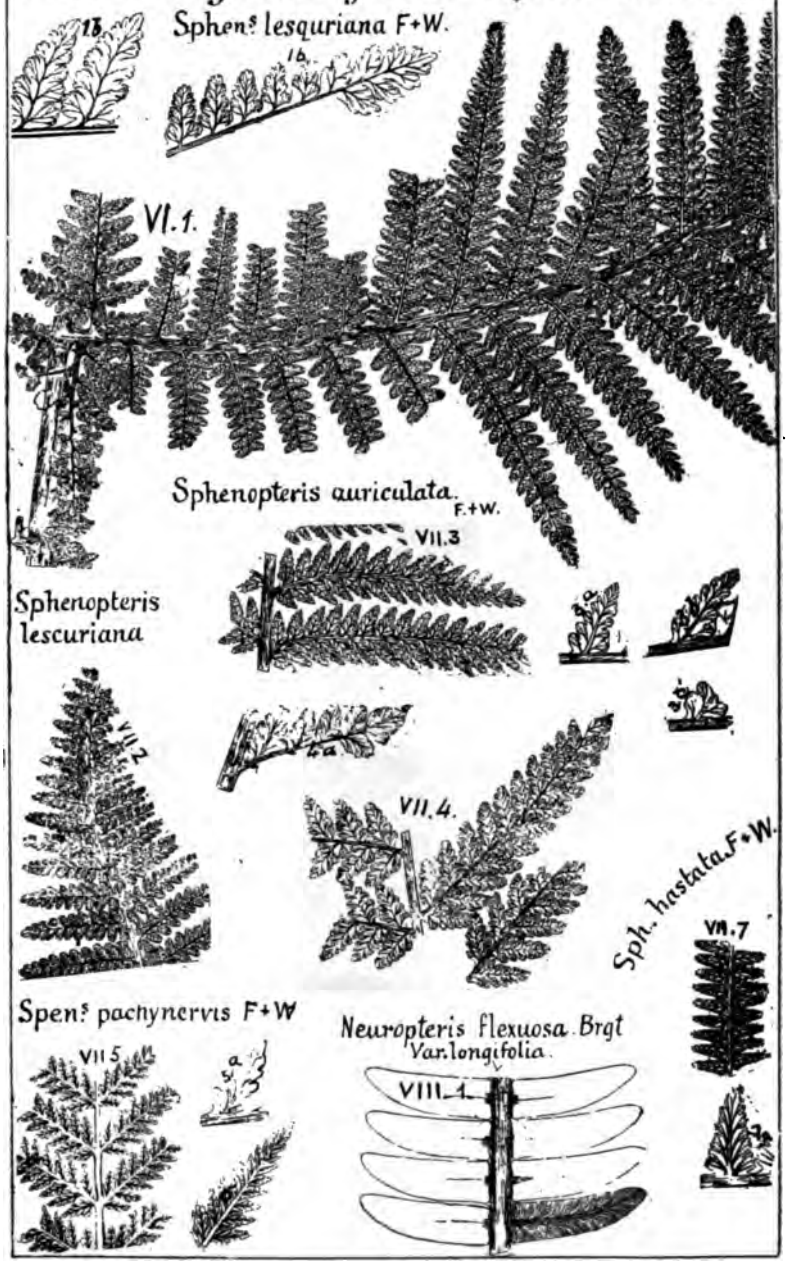
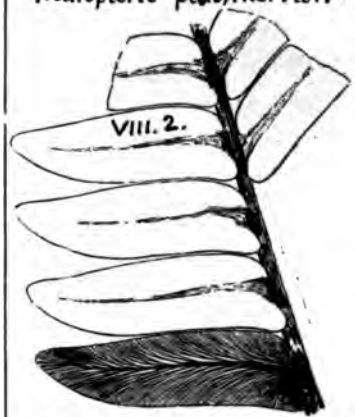


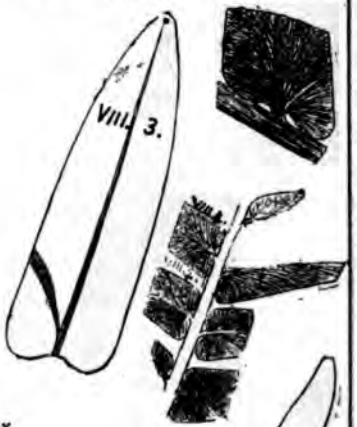
PLATE 580

XV-XVI. Waynesburg and higher coal beds

Neuropteris platyinervis. F+W.



Neur. dictyopteroides. F+W.



N. flexuosa

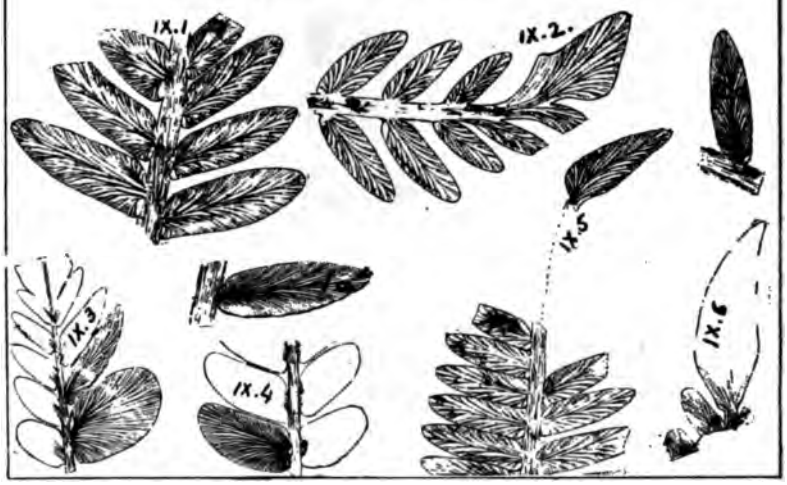


Neurop. hirsuta. Lesqx.





Neuropteris odontopteroides. F+W.



XV-XVI Waynesburg and higher coal beds

Odon. nervosa F+W



Odontopteris densifolia. F+W.



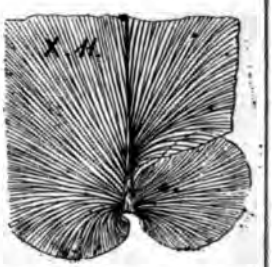






O. obtusiloba. Naum.





Odontopteris pachyderma. F+W.

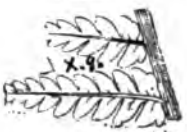
















Callipteris conferta. Bt









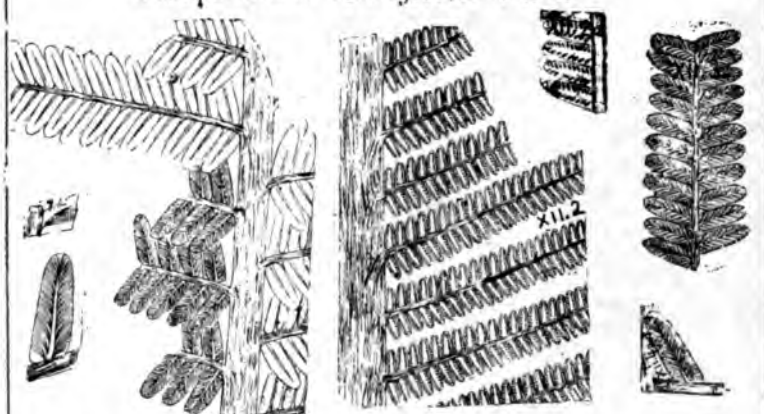




PLATE 582

XV-XVI. Waynesburg and higher coal beds

Callipteridium oblongifolium F+W





Callipteridium dawsonianum. F+W.

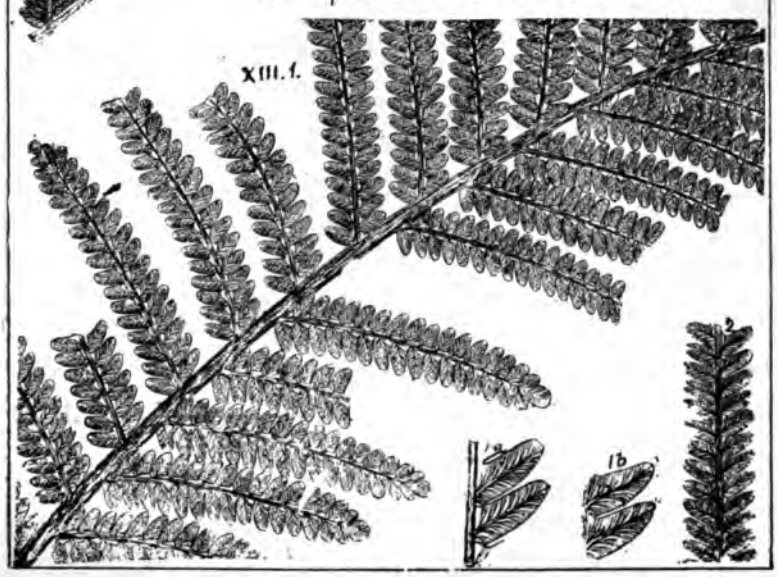
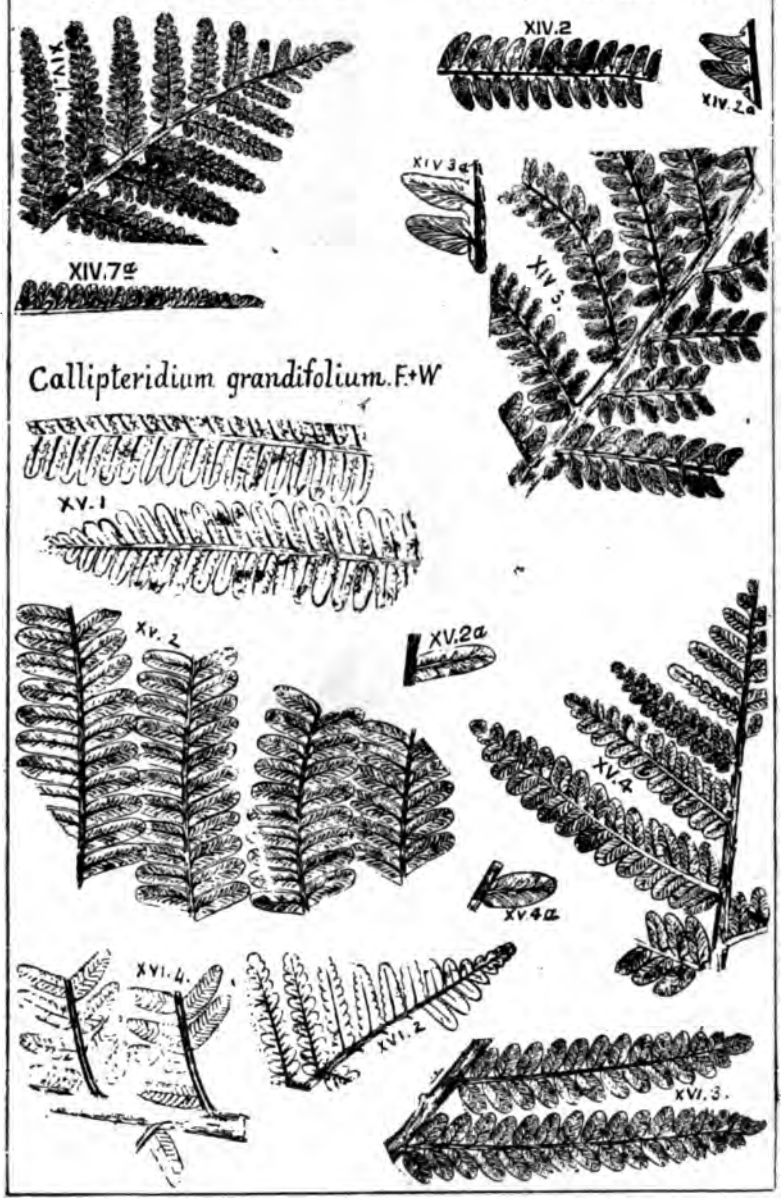


PLATE 583

XV-XVI Waynesburg and higher coal beds.

Callipt. dawsonianum. F+W

Callipt. unitum. F+W



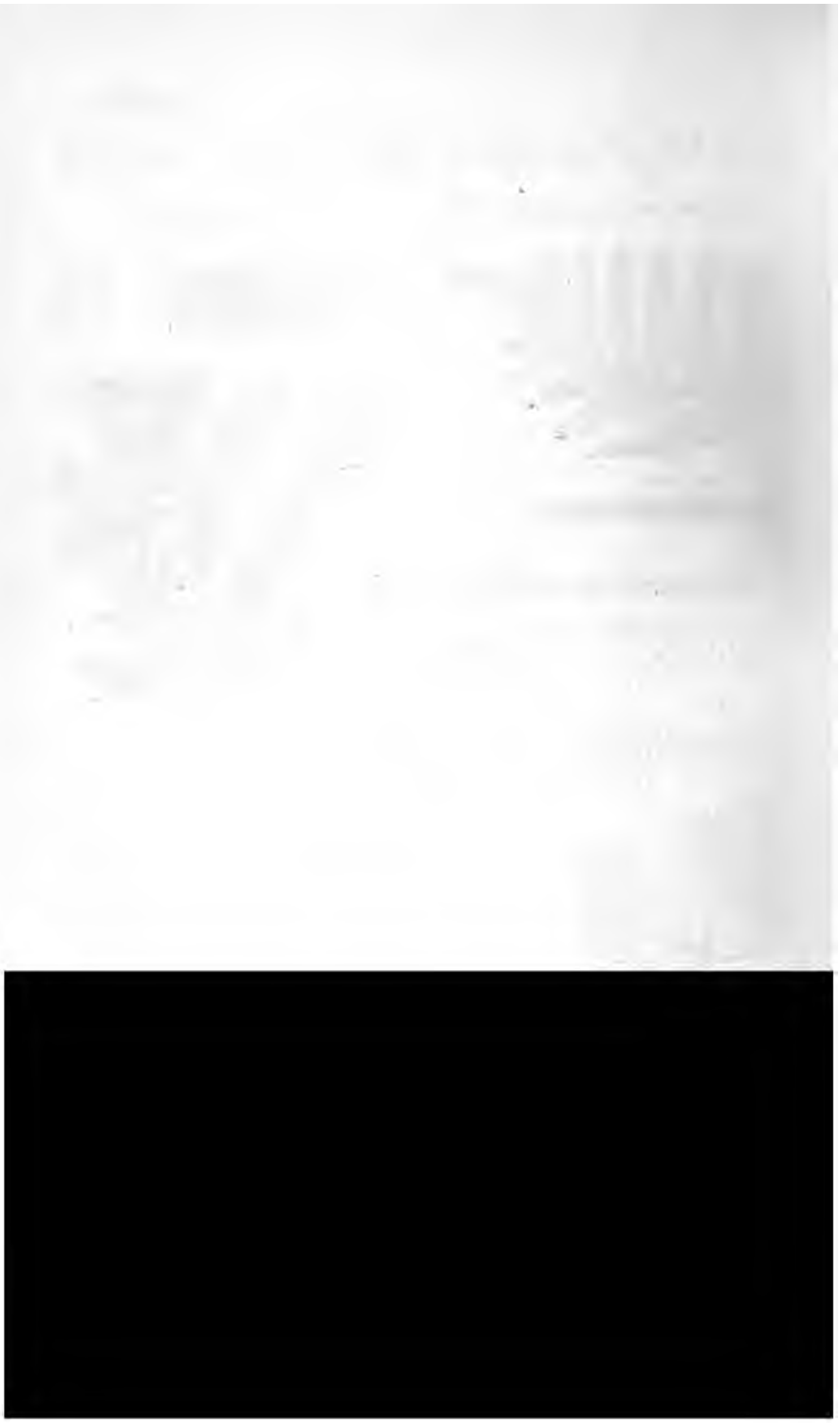
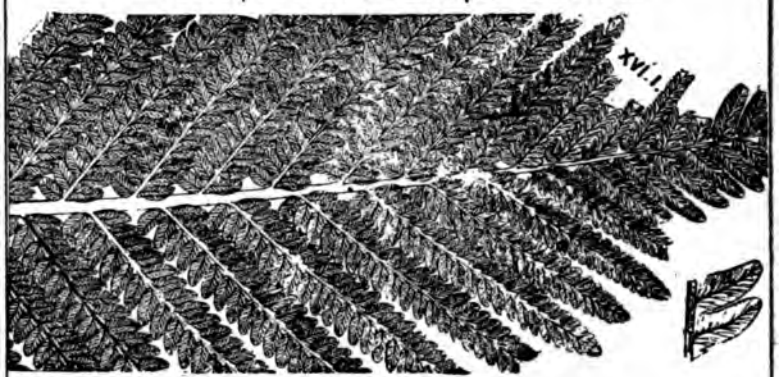


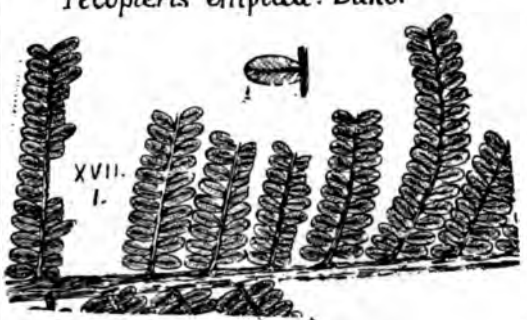
PLATE 584

XV-XVI. Waynesburg and higher coal beds.

Callipteridium odontopteroides. F+W.



Pecopteris elliptica. Bunb.



Pecopteris rotundifolia. F+W



Pecopteris pennæformis. Byt var Latifolia. F+W.

Pecopteris Sp.?











Pecopteris Sp.?





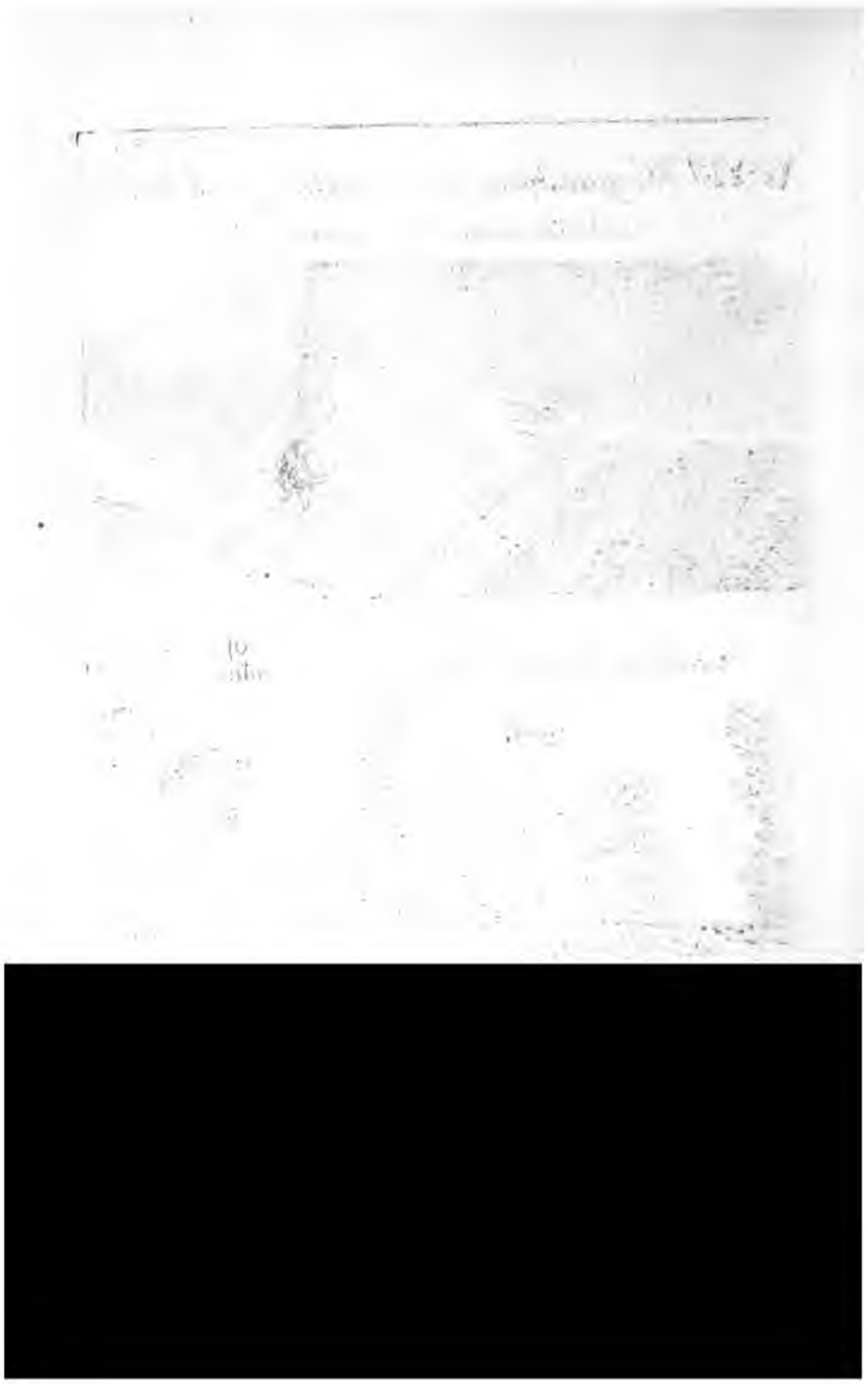
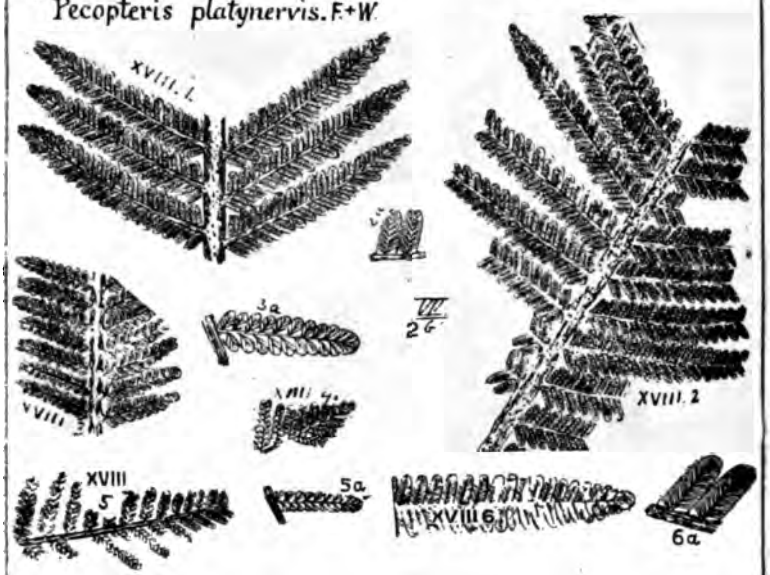


PLATE. 585

XV-XVI. Waynesburg and higher coal beds.

Pecopteris platynervis. F+W.



Pecopteris germari. (Weiss)

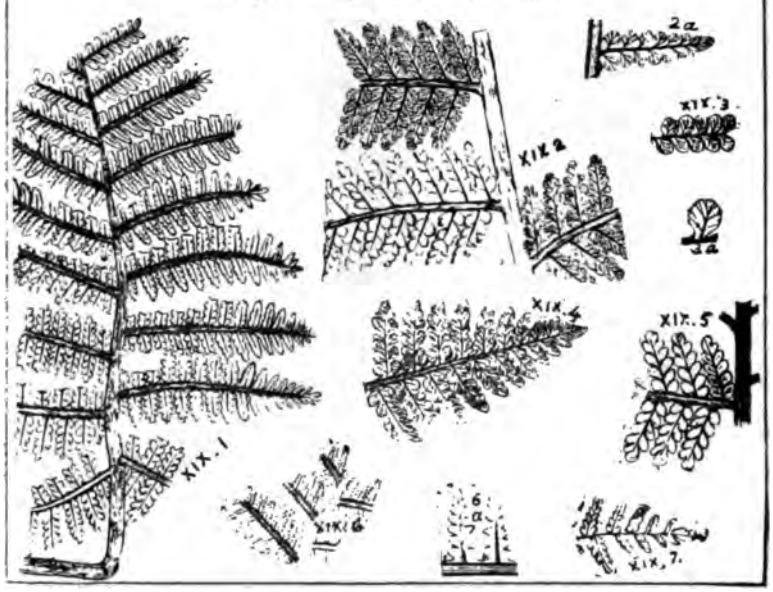
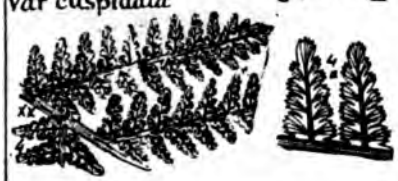


PLATE 586

XV-XVI. Waynesburg and higher coal beds.

Pecopteris germari.

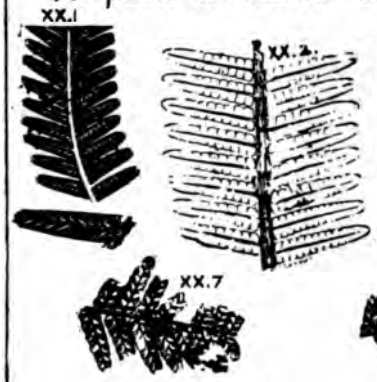
Var cuspidata



Var. crassinervis



Pecopteris candolleana Brongt



P. rarinervis F+W.



Pecopteris subfalcata F+W



P. pluckeneti. Brongt
(Var. constricta. F.+W.



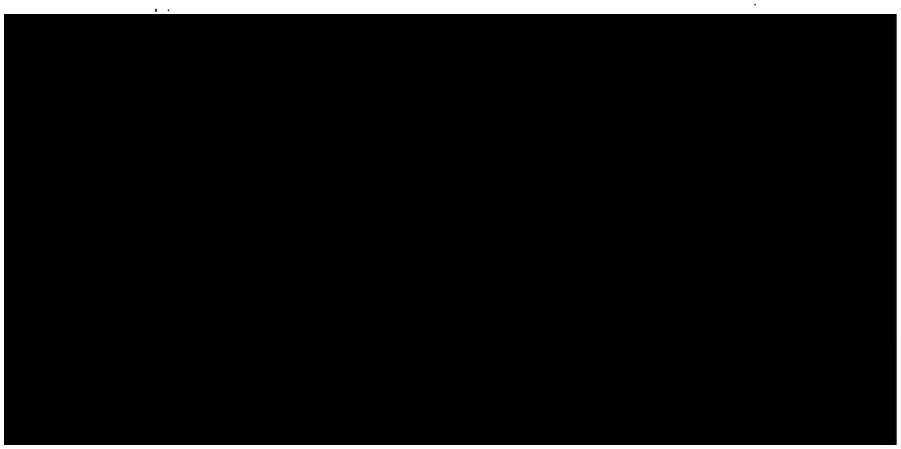


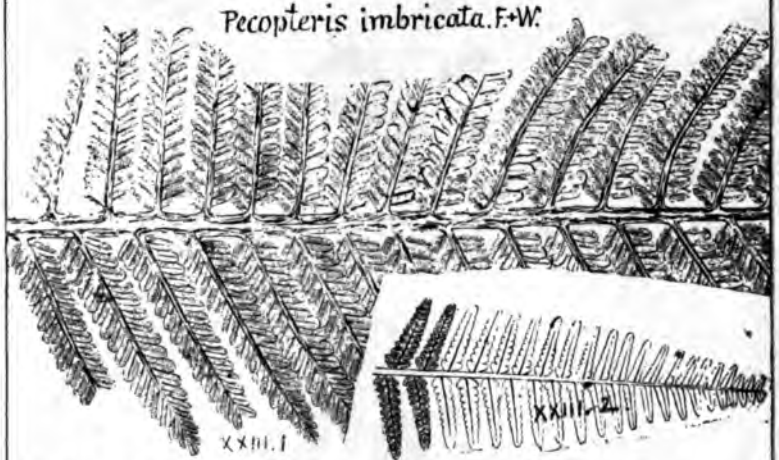
PLATE 587

XV-XVI. Waynesburg and higher coalbeds.

Pecopteris dentata Brgt.



Pecopteris imbricata. F+W.



Pecopteris schimperiana. F+W.

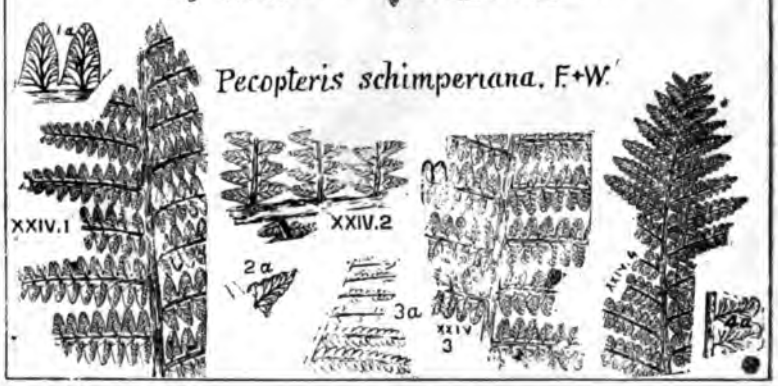
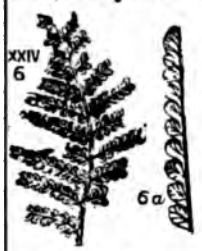


PLATE 588

XV-XVI Waynesburg and higher coal beds.

P. rotundifolia. F+W.



Sp.?



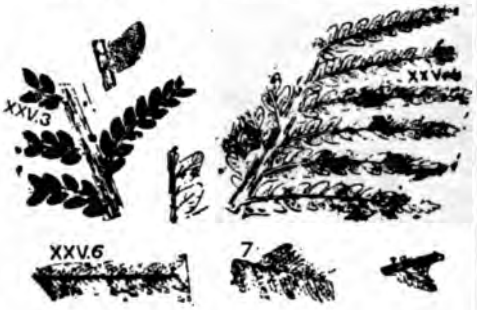
Pecopteris asplenioides. F+W.



Pecopteris goniopteroides. F+W.

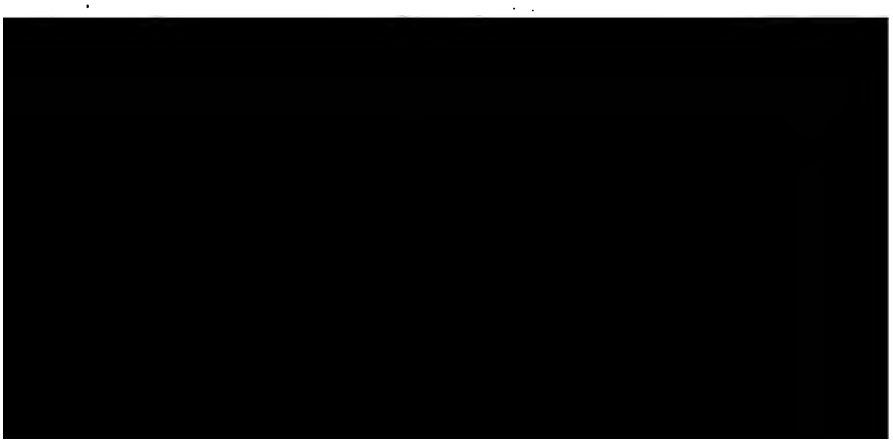


Pecopteris heeriana. Fontaine & W.



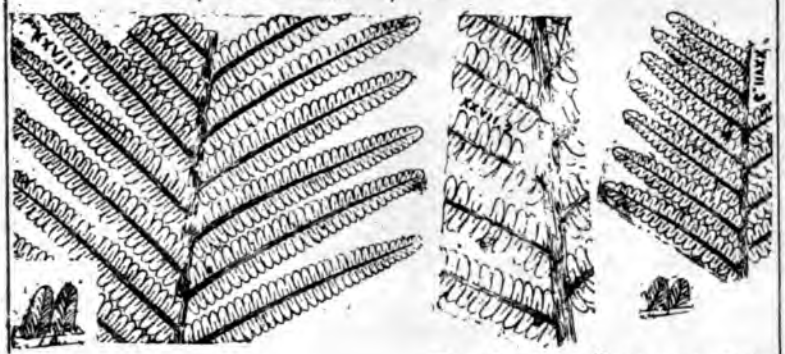
Pecopteris pachypteroides F+W.





XV-XVI. Waynesburg and higher coal beds.

Pecopteris angustipinna. F. and W.



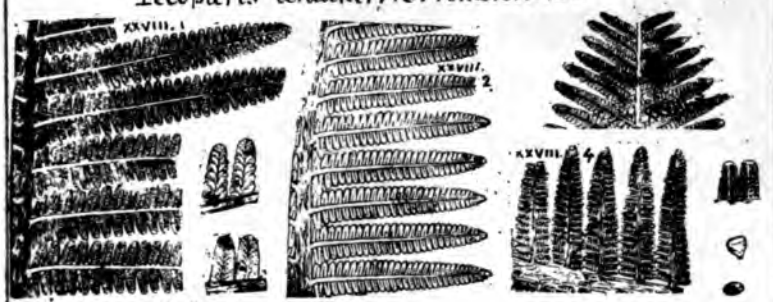
P. species unkrown.



Pecopteris arborescens. F+W.



Pecopteris tenuinervis. Fonte. & White



P. meriani opteroides. F+W



P. ovoides. F+W.



P. inclinata. F+W.



PLATE 590

XV-XVI. Waynesburg and higher coal beds.

Pecopteris lanceolata. F.+W.



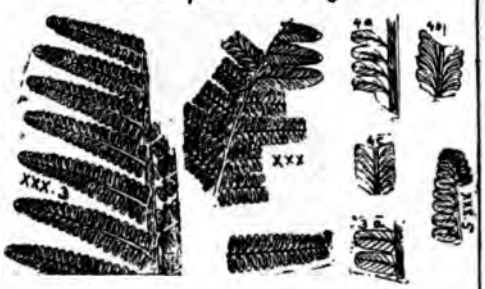
Goniopteris elliptica. F.+W.



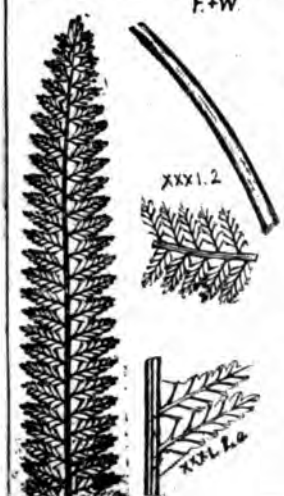
G. newberryana. F.+W.



Goniopteris oblonga F.+W



Cymoglossa formosa. F.+W



C. breviloba. F.+W.



C. obtusifolia. F.+W.

C. lobata. F.+W











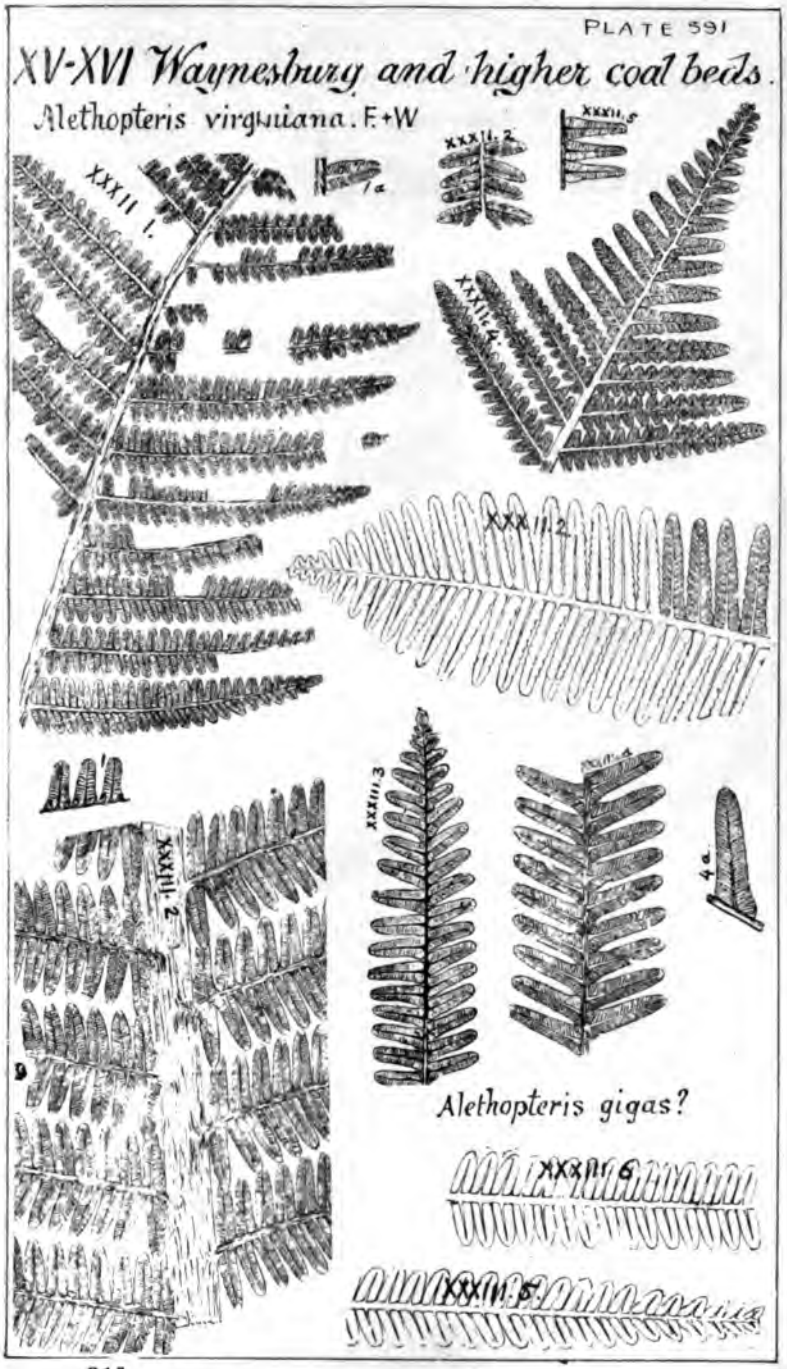
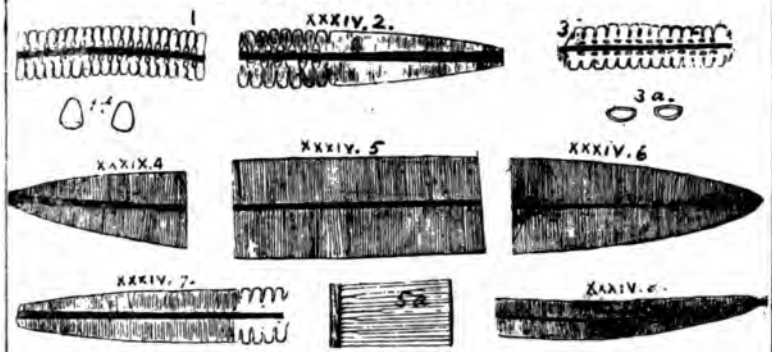

PLATE 591
XV-XVI Waynesburg and higher coal beds.
Alethopteris virginiana. F+W
XXXII 1.
XXXII. 2
XXXII. 5
XXXII. 4
XXXII. 2
XXXII. 2
XXXII. 3
4a
Alethopteris gigas?
XXXII. 6
XXXII. 5

PLATE 592

XV-XVI. Waynesburg and higher coal beds.

Tæniopteris newberriana. F.+W.



Tæniopteris lescuriana. F.+W.



Caulopteris elliptica. F.+W



Rhacophyllum filiciforme, v. majus
R. laciniatum. F.+W



PLATE 593

XV-XVI. Waynesburg and higher coal beds.

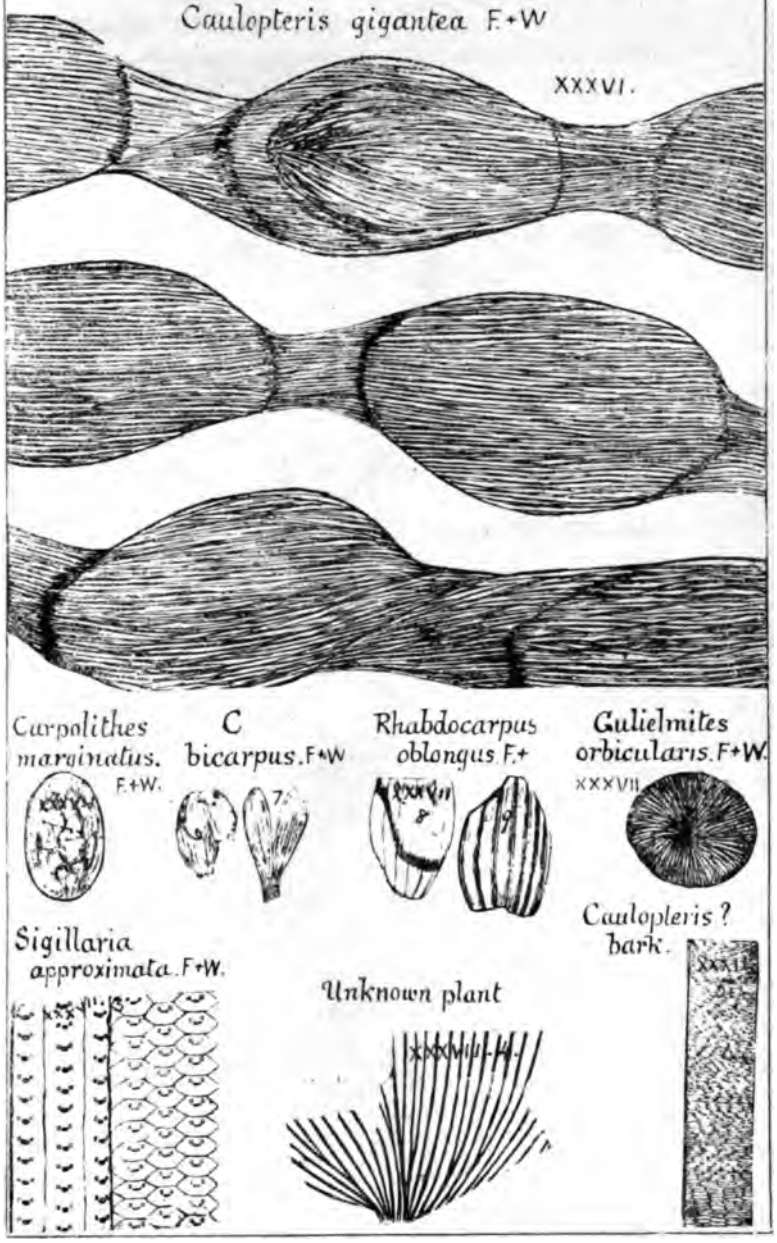




PLATE 594

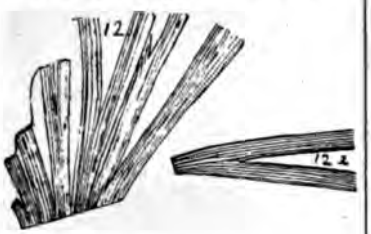
XV-XVI. Waynesburg and higher coal beds.

Cordaites crassinervis. F+W.





Baiera virginiana. F+W



Saportea salisburioides. F+W.





Saportea grandifolia. F+W.



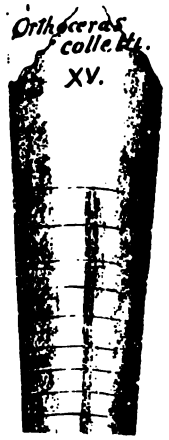


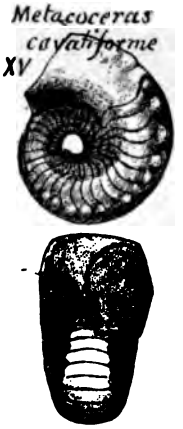


Cerablattina balteata. Scudder. (a cockroach wing.)

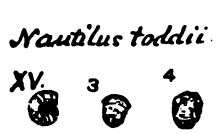
PLATE 595

No. XV. U.C.M. shells. Permian plants.







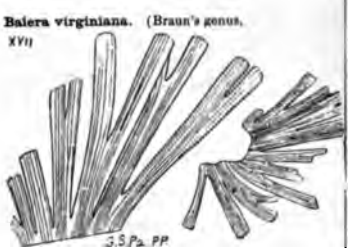




Peculiar structure of a coal bed in eastern Tennessee. J.P.L.







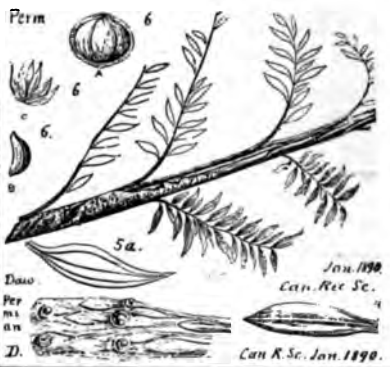
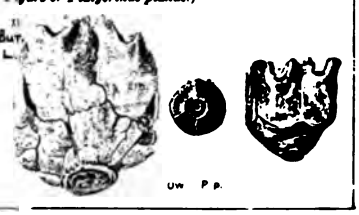


Figure of Platycrinus planus.)



Report on the New Red of Bucks and Montgomery Counties

BY BENJAMIN SMITH LYMAN.

Illustrated by a Geological and Topographical Map and Four Cross-sections.

NAME.

The so-called New Red rocks of Bucks and Montgomery Counties were formerly named the New Red Sandstoen, as if they were of the age of the British New Red and were chiefly sandstone. But perhaps hardly one-twentieth of the whole series is sandstone, and the rest are shales, much of them quite sandy, to be sure; and their age has long been universally admitted to be in the main different from the British rocks so named. The name, however, is commonly shortened to New Red, and, in case of any ambiguity, the prefix American readily dis-distinguishes our beds from the British.

Other names, too, have been somewhat used, as, Older Mesozoic, Triassic, Jurassic, Triassico-Jurassic, and Jura-Trias; also Rhaetic, from the age of the fossils of a certain part of the rocks, as established by the able researches of Prof. W. M. Fontaine. Again, the name Connecticut Sandstone, has been proposed by Prof. C. H. Hitchcock, and well defended as a designation long in use among geologists. Furthermore, the name Newark System has been strongly recommended by Prof. I. C. Russell, and vigorously seconded by Mr. G. K. Gilbert, on the ground of priority (that excellent guide in default of better ones) as having been briefly proposed about forty years ago in a foot note to a paper by W. C. Red-

field (Am. Jour, Sci., Vol. XXII, 1856, p. 357); though it was never accepted by geologists, and was long ago wholly forgotten, and in fact was in itself quite unsuitable, as will appear further on, and as has been partly explained in the Chicago Journal of Geology, 1894, p. 59. It will be seen later that none of the names indicating paleontological age, not even Older Mesozoic, will apply properly to the rocks in question. It may, then, not be altogether unpardonable, notwithstanding such eminent authorities, to designate the rocks here simply by the longest familiar and most readily understood expression, "New Red."

They were grouped together as the subject of a special survey and of this report under a universally prevalent, though, as we shall see, mistaken impression that they all belonged to one formation of narrowly restricted paleontological duration. The need or propriety of a single name to include all the beds is now in reality merely temporary, transitional, during the time it takes the geological public to become fully aware that the beds are not by any means of one closely limited paleontological period, nor even probably all Mesozoic, nor perhaps wholly distinct in their lower part from beds that occur in Western Pennsylvania, West Virginia and elsewhere associated with clearly Paleozoic formations.



The space, then, covered by the New Red is of a roughly triangular shape, with the apex towards the north on the Delaware, and the base somewhat bowed southward along the Schuylkill above Philadelphia; and with the straight boundary between the two counties running southeasterly somewhat south of the centre, so as to give more than half the field, rather rhomboidal in shape, to Bucks County.

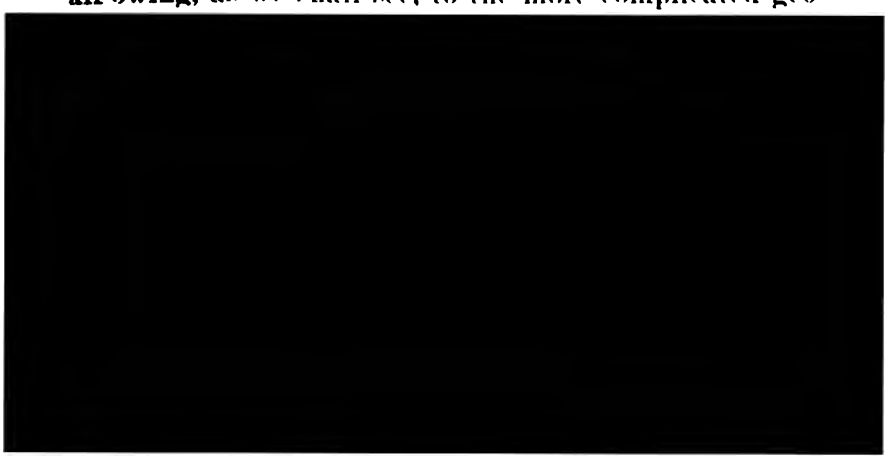
LAY OF THE LAND.

The largest tributary stream within the counties is the Perkiomen, and it flows southward from the northern corner of Montgomery county to the middle of its southern boundary on the Schuylkill, with almost easterly flowing branches on the west and almost southerly flowing ones on the east. Stony Creek and the headwaters of the Wissahickon with southerly courses occupy the more eastern parts of the county. The northernmost of the eastern branches of the Perkiomen have their heads in the northern part of Bucks County; and from the same watershed flow down easterly the headwaters of Tohickon Creek towards the Delaware. The country south of the Tohickon is mainly drained by the Neshaminy Creek, with a southwesterly course to the Montgomery County line, and thence easterly again, and later southeasterly to the south edge of the field towards the Delaware. The hook-shape so formed in the upper part of the creek is the most striking result there is in this field, of the effect of the geological structure on the course of the larger streams.

The hills, however, generally in the eastern half of the field notably conform to that structure, and have in the main a northeasterly course, with some irregularities near the Delaware south of the Paleozoic "island." In the southern part of the western half, near the Schuylkill, there is something of the same regularity; but all the more northwestern parts of the field are much more irregular, in agreement with the geological structure

there. The southern edge, and still more the northern one, is bounded by a higher rim of older rocks. The field itself is mostly low, but uneven, with no very extensive plains, and yet not with any uniformly rolling character. The height of the land is less than 300 feet above the sea along the southern edge of the field and near the two large rivers; but at a distance from them, rises on the whole gradually, so that most of the northern half and a small adjoining part of the southern half are more than 300 feet above the sea, and northward have here and there hills of 600 feet high, and even at one point, Haycock Mtn., over 900 feet above sea level. The shape of the surface shows in general, then, a decided conformity to the geological structure to be explained more fully further on, the harder beds standing out more or less prominently above the softer ones, and the whole not yet worn down to one level.

The common roads have mainly been laid out with great reference to the course of the hills, either parallel to them or squarely across them. Consequently the roads in the eastern and southern halves of the field usually run northeasterly and northwesterly, at right angles; occasioning too a similar arrangement of the boundary lines of the townships. But in the northwestern part of the field the arrangement of the roads and boundaries, like the hills, becomes much more confused; all owing, as we shall see, to the more complicated geo-

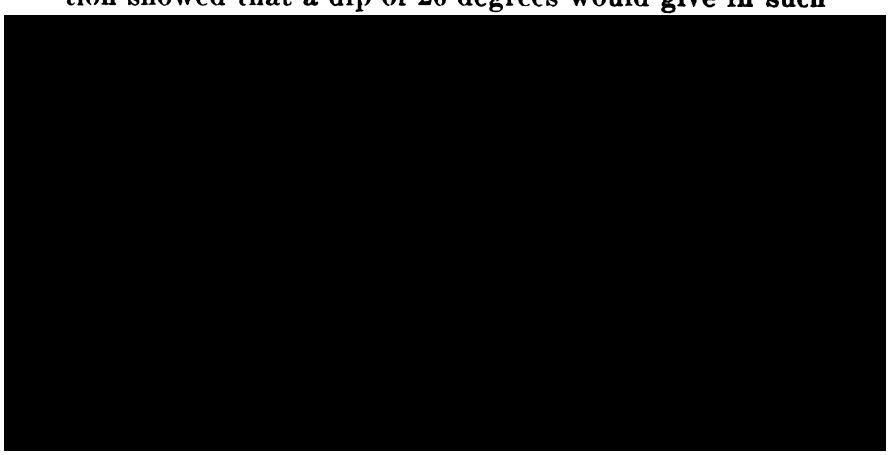


very far from exposing anything like a continuous section of all the rockbeds.

The largest town in the field is Norristown, the capital of Montgomery County, on the Schuylkill, a little west of the middle of the southern edge of the field, with Bridgeport, a large place, just across the river; and the second largest is Pottstown, also on the Schuylkill at the western end of the field. Doylestown, the capital of Bucks County, is within the peculiar hook-shape of the upper Neshaminy Creek already mentioned. Quakertown is on the Bethlehem line of railroad, in the midst of a rather wide basin-shaped plain near the middle of the northwestern edge of the field. Lansdale is an important town at the junction of the Stony Creek and Bethlehem lines of railroad; and North Wales is a couple of miles southward on the Bethlehem line, and Ambler four or five miles still further south; and Souderton and Telford five and six miles northward on the same line, and Sellersville and Perkasie four and five miles still further north upon it. Pennsburg and East Greenville form almost a continuous town on the Perkiomen Railroad near the northern corner of Montgomery County. Newtown is a town of importance inside the eastern corner of the field, and Yardleyville one at the eastern corner; Hatboro one on the Old York Road halfway between Newtown and Ambler; New Hope one on the Delaware near the end of the island-like patch of Paleozoic rocks; Oaks one at the mouth of the Perkiomen; Linfield, and Royersford two on the Schuylkill, five and seven miles southeastward of Pottstown; and Tylersport still another at three miles northwest of Telford. There is a very large number of other towns, many of them enterprising places, scattered pretty uniformly over the whole field, according to the agricultural capacities of the land; but none of them apparently with as many as 500 inhabitants in 1890.

GEOLOGY.

The geology of the field was formerly supposed to be in certain respects very simple, but in certain others very mysterious. The structure was taken to be in the main unvarying, with everywhere a northnorthwesterly dip of 10 to 25 degrees, averaging 15 to 20 degrees, and near the Delaware uniformly about 20 degrees (Rogers, State Geological Report of 1858, Vol. II, p. 670). The somewhat prevalent red color of the beds, together with their otherwise strong resemblance in great part and their conformity throughout and the general lack of fossils, had led not unnaturally to the widespread but, as we shall see, wholly erroneous conjecture that all the New Red beds both here and in the neighboring states, everywhere alike, belonged to a single quite limited paleontological formation; and that they consequently could not be, all together, of very great thickness, perhaps not more than 3,000 or 5,000 feet, as intimated, for example, by Dana. The conjecture from mere repetition became in the course of time generally accepted, because no economical or other reasons had occasioned any thorough investigation of the facts that would refute it. The mystery then was, how so small a thickness as that could cover a breadth of thirty miles or more with a uniform dip of 20 degrees. A simple computation showed that a dip of 20 degrees would give in such



the paleozoic "island" destroys that proof. Against the false-bedding theory, it was conclusively objected by Hitchcock, in 1858, that the fossil footprints did not appear to have been made on an inclined surface; and by Cook, in 1886 and 1888, that not only the tracks and rain-drops had fallen on a level surface, but ripple-marks and flat-lying pebbles indicated the same level deposition, and the materials had come from the northwest as well as from the southeast; and by Newberry in 1888, that the numerous beds of thin-leaved shales, and the limestone beds must have been laid down in deep water horizontally.

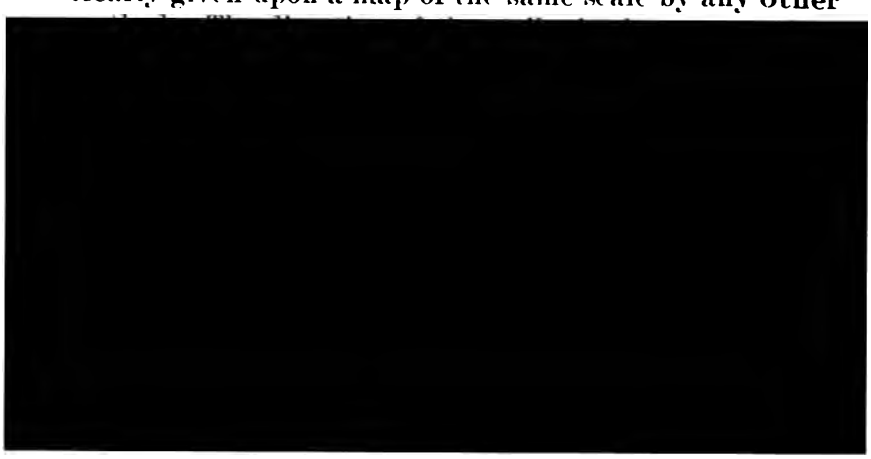
Again, it was suggested that great parallel faults lengthwise of the formation with upthrow always to the northwest would bring the same beds repeatedly to the surface, and so require but a moderate total thickness. The thickness of the whole formation in York County was in that way thought by Dr. P. Frazer not very greatly to exceed 1,500 feet. Prof. Davis showed ingeniously and persuasively how such parallel faults might have arisen in Connecticut. The recurrence of similar-looking parallel hills of red beds of resembling material in New Jersey, pointed out by Cook, lent the theory some color, literally; but scarcely did more, as there was hardly any other observed fact to support the idea. For not only does a careful examination of extremely numerous exposures fail to show any important faults, though many trifling ones; but the complete working out of the geological structure, presently to be described, does not disclose more than a single large one, and even shows by the complicated structural irregularity through a great part of the field that long, straight parallel faults would be wholly incapable there of diminishing the total thickness required.

It is evident then that the present survey had to attack weighty problems, and that there was special need to be on guard against any bias from generally accepted opinions and undue influence from the great names or personal friendship of predecessors. The main ques-

tions were the geological structure and the columnar section, with the thickness of the formation and of its principal parts. The known fossils, if their stratigraphic relations could be ascertained, might give some indication of the age of the different sub-divisions of the columnar section. There was further some occasion to consider certain much disputed points in regard to the form of the deposits of trap-rock among the New Red beds. The economic geology, though of little importance compared with many other parts of the State, is not altogether insignificant; and especially a lack of geological investigation might easily give rise here to a great waste of money in fruitless attempts at mining.

STRUCTURE.

To ascertain the structure, a couple of thousand dips have been observed, recorded and plotted, covering satisfactorily every part of the field, and leaving no spaces between them so large as to make possible the existence of any important divergence from their indications. The dips are all marked in respect to their place, direction, amount and degree of certainty upon the printed map by a method that is somewhat unusual, but that has proved its extreme convenience and usefulness through more than twenty years' varied experience. Such numerous facts of that character could hardly have been clearly given upon a map of the same scale by any other



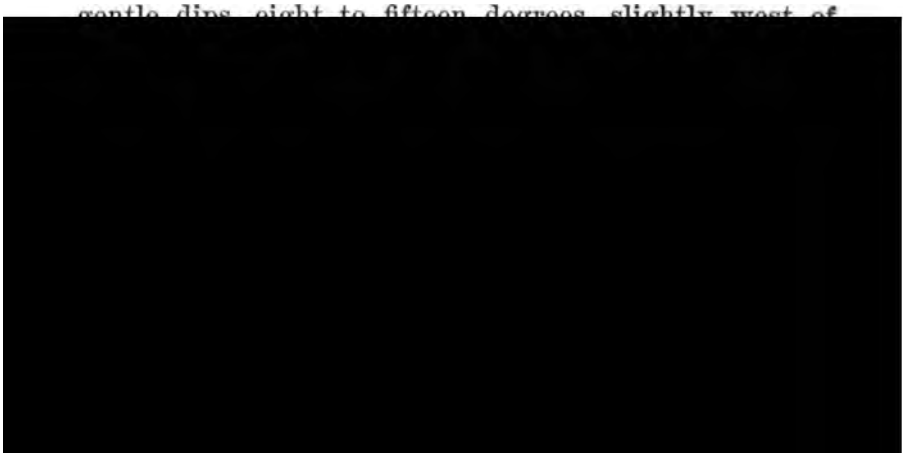
short a space. Of course, in any one dip observation, there are manifold causes that may lead to an erroneous result. There may be, in the first place, a mistake in selecting the plane of inclination: For example, taking a cleavage plane or a false-bedding, or cross-bedding, plane, for the true plane of bedding; or not perceiving that the bedding plane, has been displaced from its proper position by "creep," or sliding down hill, or otherwise; and even if the right plane be taken, the line of greatest steepness for the dip, or of level for the strike, may be wrongly selected, especially where the dip is gentle or the bedding uneven. Or again, the angles may be misread; for instance, by mistaking the quadrant of the compass, or by counting the wrong way from the ten-degree marks of either the compass or the clinometer; or the clinometer may slip before it is read. But the map with its numerous dips shows that they mostly corroborate one another very well, and prove beyond a question the correctness of the structure inferred.

Furthermore, the structure indicated by the dips is confirmed by numerous cases of identification of beds at distant exposures through corresponding columnar sections and comparison of rock specimens, as well as in a general way by the color of the decomposed outcrops of the beds as shown in the roads and ploughed fields; and also by the topography of the surface. Advantage for that purpose was taken of the excellent topographical map with ten-foot contour lines made by Mr. Rudolph Hering and his assistants for the Philadelphia Water Department, and published in 1887 by the State Geological Survey, and covering the Perkiomen and Tohickon valleys, nearly one-half of the field of our map, and imagined to cover the whole field at the outset of our undertaking. The rest was filled out by less elaborate topographical work of the present survey, with aneroid levels and hasty sketching, and after the map was finished was partly replaced on the east by copying some newly published topography of the United States Geological Survey.

The structure is shown on the map by blue lines analogous to contour lines of the surface. The blue lines might be called equidistant strike-curves, and are curves one thousand feet apart in level, representing the position of the bottom of the five different sets of beds. Near the outcrop of the bottom of each set of beds, one blue line gives the sea level line of that bottom; the next line to the deep is one thousand feet below sea level; the next, two thousand feet; and so on. The distance of the lines apart shows, therefore, the steepness of the dip everywhere.

It is readily seen, then, that through a large part of the field the dips are indeed gentle northwesterly ones, as they were formerly supposed to be everywhere, and as they might well seem to be universally, if only looked at cursorily in traveling along the railroads and rivers. Yet, in other parts of the field, especially towards the northwestern border, and south of the Paleozoic near New Hope, it is obvious that the structure is much less simple through quite extensive spaces.

Even along the southern edge of the field the beds are far from lying in a monotonously uniform shape; but are gently, though on the whole very decidedly, waved, at least through the eastern half of that edge, with northerly dips of eight to fifteen degrees. Along the Schuylkill, however, there is much more uniformity, with gentle dips, eight to fifteen degrees, slightly west of

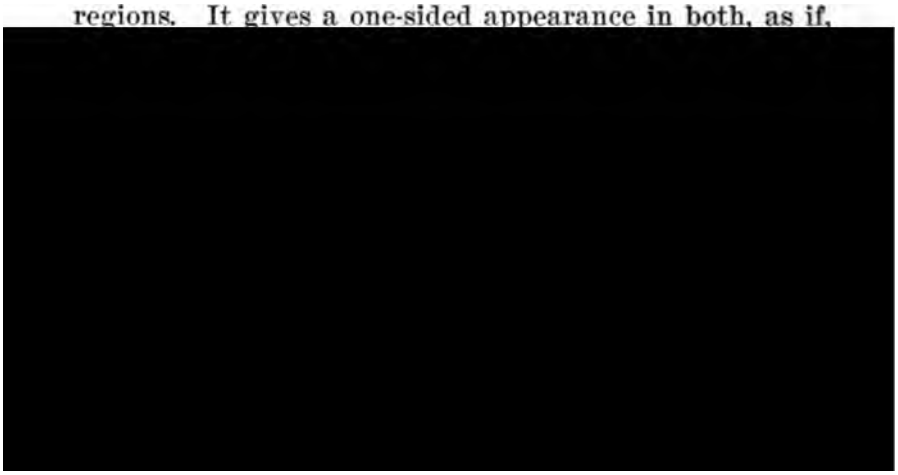


come together at the New Jersey end of the Paleozoic and at the western end near Doylestown; differences of about 14,000 feet there and 4,000 feet here. Prof. Lewis, however, did not have the opportunity of fully investigating the fault, and was under the mistaken impression that it had caused a heave (or horizontal dislocation) of four or five miles in a nearly vertical dike of trap. Also he mistook for confusedly broken fault-rock, as he supposed a hundred feet wide, certain dark shales in the railroad cut at Chalfont, west of Doylestown; shales that from one point of view, from the east, can be distinctly seen to be regularly bedded, though somewhat sharply folded and much fractured by numerous cleavages. Westward from the Paleozoic, the fault gradually dies out and disappears at a distance of about eighteen miles, but is replaced by a saddle or anticlinal in the rock-beds that continues northwestward to the limit of the field.

Southwest of the saddle, and between it and the neighborhood of Pottstown, the rock-beds form a deep basin, running northwesterly and containing the geologically highest rocks of the whole of the New Red of the two counties. The dips on the eastern side of the basin, near the edge of the field, not far from Boyertown, Berks County, gradually steepen to ninety degrees southwesterly, the only place where such steep dips have been observed in our New Red. In other parts of the basin the dips are generally much less steep, but on the two sides frequently as much as 25 or even 30 degrees. The country northeast from the saddle to the Delaware is filled by three shallow basins, with axes running northwesterly, and the middle one with a branch running northeasterly. The dips in these basins are mostly under 20 degrees, and in the central parts and in the easternmost basin down to eight degrees or less. Southeast of these eastern basins, as far as to the Paleozoic "island," the rock-beds lie very uniform, with gentle northwesterly dips of about ten or fifteen degrees.

It is noticeable, then, that along the northwestern edge of the two counties there are decided basins and saddles with axes at right angles to the general trend of the New Red and to the prevalent strike of the rest of the field; and that one of the saddles curving eastward becomes a great fault and bends northeastward along the southeastern edge of the Paleozoic "island," growing deeper and deeper all the way to the Delaware. It is striking, too, that both just south of this Paleozoic patch and along the northwestern edge of the field, in the two places, namely, where the fullest thickness of New Red rocks exists, the greatest contortion and irregularity of folding also occur. It is just in those places that the floor has sunk to the greatest depth, pressed down, no doubt into the underlying rocks, that must necessarily be plastic under the enormous weight of the immense thickness of beds. The same result is to be seen also northeastward, in New Jersey; and again in the Connecticut Valley, though here the thicker remaining part of the New Red is on the eastern side, owing to a more prevalent dip in that direction.

It is not clear at first view why the beds should have settled down to so great a depth mainly near the northwestern edge of the New Red in Pennsylvania and New Jersey, but near the eastern edge in Connecticut and Massachusetts, instead of along the middle line in both regions. It gives a one-sided appearance in both, as if,



that side of each region where now the greatest sinking has taken place. The greater thickness of beds in the deeper part of each may have been occasioned by the extent and steepness of the drainage of the adjacent ancient rivers and the character of the rocks they eroded.

The great diversity in the direction of the axes of the several rockfolds in the field, all presumably of contemporaneous formation, is of itself a refutation (if any were still needed) of the old ideas of the universal parallelism of axes of the same age, as if there were something of a crystallizing tendency in all the globe as a whole, with world-wide planes and great circle lines of activity. On the contrary, the folding would seem to have been guided simply by the lines of least and greatest resistance, by the thickness and cohesion of the beds folded, and by the prominence and firmness of the older ridges that could resist and bound the movement of the more recent rock-beds lying between them. The thickness and cohesion of the beds are of course determined by the shore line, currents and neighboring rivers of the sea of the time when the beds were deposited, and by the quantity and character of the eroded material brought down by the streams of that time. The prominence and firmness of the older ridges depend in the same way on the like conditions of an earlier period and on the subsequent folding of the ancient rock-beds then formed. The great axial directions, then, would roughly be some guide to the history of the outline of the seacoasts at different epochs. The axes of the folds of rock-beds might very well in any given region be parallel to more ancient axes of the same region, as, in a general way, they are in parts of these two counties. On the other hand, at short distances apart, axes of the same age might widely diverge, as they do in these two counties. This difference in the direction of the northern axes from the main ones seems likely to be due to the irregularity of the ancient shore line there, as shown particularly in the adjoining part of New Jersey.

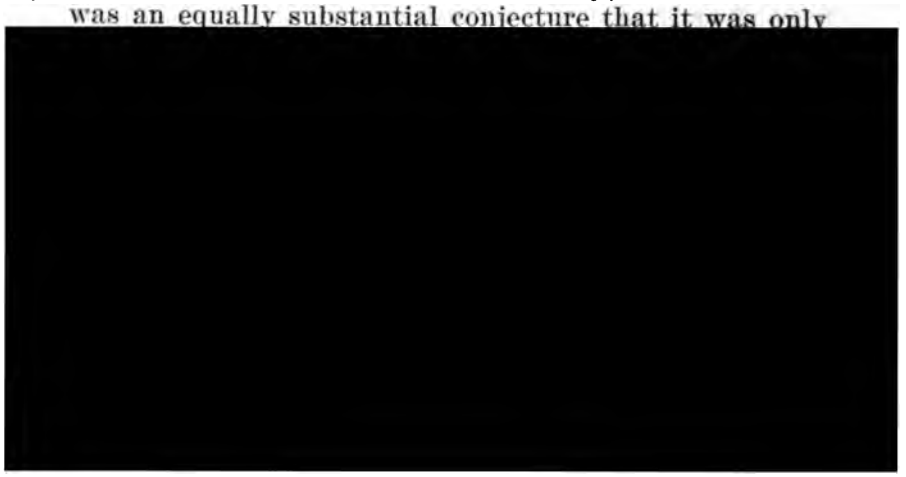
A hill about a thousand feet high at the northern edge of the field and half a dozen miles from the northernmost corner of it was formerly supposed to be made up of New Red rocks, as mentioned in Report X, p. xxix; but it seems rather to consist of the quartzitic early Paleozoic sandrock called Chikis Sandstone, or No. I, which is here more or less reddish and covers the ground with a reddish hard gritty sand similar in color but different in character from the New Red materials.

Rocks.

The rocks of the field are chiefly sedimentary; but partly igneous, or trap. Let us first consider the sedimentary rocks.

Sedimentary Rocks.

It was formerly supposed, without particular investigation, that the total thickness of the New Red was everywhere the same; and it was far from being suspected, what now appears to be the fact, that the thickness existing in and near Montgomery County was decidedly greater than elsewhere. It has already been shown that although the total thickness had come to be generally accepted as some 3,000 or 5,000 feet, it was only so by mere repeated conjecture, or assumption, in the absence of any proof to the contrary; and that there was an equally substantial conjecture that it was only



dip near the Delaware was too high at 20 degrees; so that, with the repetition of many beds on account of the great fault, and with the irregularities of structure south of it, the total thickness of the beds is much less than the 55,000 feet that the dip and the space covered formerly seemed to require. It is evident, too, that the total thickness of New Red along the Schuylkill, in Montgomery County, notwithstanding the much smaller breadth, is about the same as along the Delaware; and that the series of beds along the two rivers happen to be almost identical. But between the two rivers, several thousand feet of additional thickness occur both at the top and bottom of the column, owing to the deep basin north of Pottstown and the broad saddle, or anticlinical, east of Norristown.

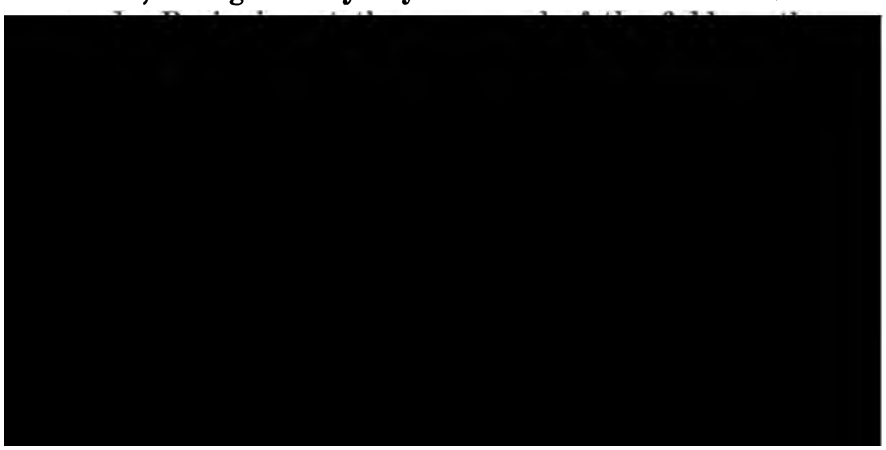
Instead of taking in one simple estimate a breadth of thirty miles and seeing what thickness it would give for an assumed average dip, much more detailed measurements have been made. Indeed, any other course would have resulted in merely adding one more conjecture to the numerous old ones; and however accurate, it would have found no acceptance, on account of its differing, yet without demonstration, from the conjectures that had already gained general credence. It became necessary, therefore, for a result of any value whatever, to undertake much more thorough, laborious and time-consuming observations, notes, drawings and computations than would in ordinary cases have been worth while.

In addition to the couple of thousand dip observations recorded on the printed map, a couple of thousand separate rock exposures were carefully examined and noted as to the character of the beds, with about four thousand samples taken of the many varieties of rock, for the sake of subsequent comparison, and with measurement of the different layers; and the columnar section of each exposure was not only minutely noted in the field, but was drawn in the office to one uniform scale, to aid in the identification of beds at distant points. The exposures were many of them very large, including particu-

larly all the cuts along the railroads and the cliffs along the rivers and the Neshaminy, besides the quarries and the exposures along more than half the roads that cross the strike nearly at right angles, as well as many other roads and streams.

Extensive as is the combination of all these special columnar sections there are many gaps between that are not filled by the beds of any observed exposures. The amount of those gaps therefore can obviously not be measured on the beds themselves, but must be estimated or computed in each case by the steepness of the dip and the distance from one exposure to the next adjacent one, taking account also of any difference there may be in the level of the exposures. The observed exposures are so numerous and so near one another and the dips in general so gentle in steepness and so uniform in direction, or so very gradually changing, that the inaccuracy of such a method of computation cannot be important. Moreover, any errors in estimating the dip in the gaps between exposures would be just as likely to be in excess as in diminution, and so would tend to balance one another. The result consequently for the whole columnar section is not likely to be very erroneous.

A sufficiently large number of the observed exposures have been made use of in the very laborious computation of the general section to insure an amply satisfactory result; though not by any means all of them were reck-



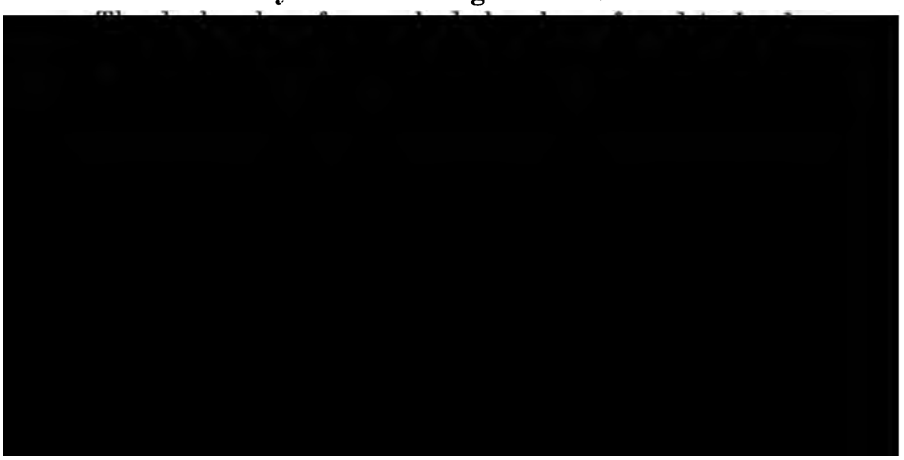
all), a full series along the Perkiomen and along the Schuylkill, including the Reading Railroad on both banks and the Pennsylvania Railroad on the east bank down to the southern edge of the New Red, and thence eastward to the Delaware, and all along the Delaware, and nearly all along the Neshaminy below Chalfont, and all along the Bethlehem, Stony Creek, Newtown and Bound Brook lines of railroad.

In many cases a small and sometimes a very large portion of the general columnar section was computed from exposures near one another along one route, and compared with the results of a like computation along another route, forming a polygon, and, after the detection of any errors, the small remaining difference was adjusted in each case in the way that seemed most reasonable; for example, by a slight steepening or lessening of the estimated dip between exposures, especially where the dip appeared least certain. The comparison of such duplicate portions of the whole column also required that there should be nothing inconsistent in the rock-beds that were found to occur in them at the same horizons. At many points where distant exposures were evidently on the same strike line it was possible to identify the beds through the similarity of the succession in both character and thickness, either by the descriptions noted in the field or by a comparison of the specimens collected.

It is plain that such close identification of layers at exposures several miles apart could in general never be made by means of fossils alone. For, in the most favorable case, a numerous assemblage of fossils of one kind in one thin layer represents the remains of something like a single school of fishes, or an oyster bed, or a bank of seaweed; and such collections of organisms of one kind would naturally be of limited extent, and might very well not be found persistent to a distance of several miles. So that, even, the presence of a similar mass of fossils of one kind at distant points would rather be presumptive evidence that the layers were not identical. On the

other hand, the mere recurrence of a few scattered fossils of several kinds would not of itself conclusively identify a particular layer, because such kinds would be likely to have existed together throughout the deposition of many layers. Clearly, for a close identification of beds, fossils would be but a subordinate aid, and one only comparable at best to the lithological character of the layers.

It was found that the rock-beds were by no means of a wholly uniform character and color; as, indeed, had to some extent been understood long ago, though a departure from the more prevalent red color had sometimes been supposed to be mainly or solely due to alteration through the heat of neighboring igneous rocks. Rogers divided the New Red into three members: Upper and lower conglomerates of pebbles from adjacent older rocks in a red shale cement, and between the two, red shales and argillaceous red sandstones; yet in parts with dark colors and indurated shales, owing to trap-dikes near, or much igneous rock below the surface, particularly towards the Delaware and in northern York County. The conglomerate character, however, may be due merely to the proximity of the source of the pebbles, and may therefore occur in many horizons near the mouths of the rivers of the New Red time, though beds of the same horizons at a greater distance from the ancient shores may have a finer grained texture.



it hardly possible at present to suggest a better division. Perhaps in the course of time future discoveries of fossils may enable geologists to divide the series in another way; or at least to move the limits between these divisions up or down a little so as to conform better to paleontological requirements. The differences of color and character may indicate changes in the streams and currents and sediments of the New Red seas that corresponded to changes in the organic life of that time. At any rate, the strongly marked differences of color will give fixed points to measure from in adjusting any future discovered paleontological limits. In the main, the sub-division at present adopted is into two sets of hard, dark shales, with soft red shales above and below each set, and with the lower set of dark shales thicker, blacker and more carbonaceous than the upper one.

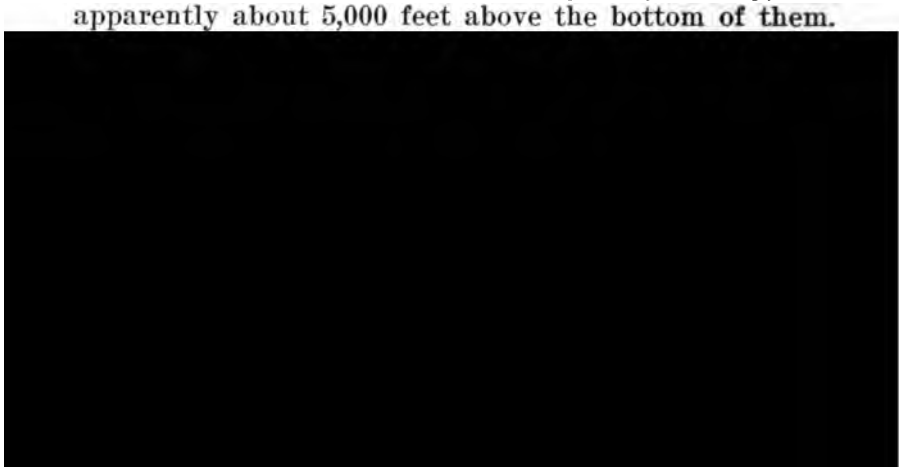
The whole series, so far as it occurs in Montgomery County, proves, then, to be at least about 27,000 feet thick; and to consist of the following five sub-divisions, beginning at the top: Shales, mostly soft and red, near Pottstown and northeastward, about 10,700 feet thick; shales, in great part hard and green, at the Perkasie tunnel and near it, about 2,000 feet; shales, mostly soft and red, at Lansdale and near it, about 4,700 feet; shales, in great part hard and very dark colored, at the Gwynedd and Phoenixville tunnels, about 3,500 feet; shales, mostly soft and red, at Norristown and eastward, about 6,100 feet.

Pottstown Shales.—The 10,700 feet in thickness of shales at Pottstown and northeastward are mainly soft and red and generally somewhat calcareous, with a few scattered green layers. There are also a few thin limestone beds about 4,000 feet above the bottom of this set of shales, and they are exposed near Pennsburg. Although most of the layers of the set are quite soft, there are numerous harder layers; scarcely any, however, very hard or of such thickness as to make important hills, in spite of rather numerous roadside exposures of thin somewhat firm beds. The space underlain by the shales is con-

sequently for the most part rather flat, low-lying, fertile ground, except where beds of hard trap have protected the shales from erosion or have left them covered with scattered blocks, or where the very flatness has occasioned swampiness. Not only the immediate neighborhood of Pottstown, but the plains of the townships northeastward, Douglass, New Hanover, Frederick, Upper Hanover, and around Quakertown are illustrations of the topographical effect and of the general softness and fertility of this set of shales. The lower part of them also shows a little near Kintnersville and Monroe on the Delaware; but is much covered with trap blocks and decomposed trap earth.

The geologically highest beds of the field occur at about the middle of the northwestern boundary line of Montgomery County, a mile and a half northeast of Boyertown, Berks County. Whether still higher New Red beds occur in Berks County is not known; but probably there is no very great additional thickness of them.

The Pottstown Shales are not well suited to preserve fossils; but a few small very imperfect plant remains have been found in them within our field. The only recorded fossil from them anywhere is the Clepsysaurus Pennsylvanicus, Lea (Journal Acad. Nat. Sci., 1883, p. 185), from Upper Milford township, Lehigh County, just outside the northern corner of Montgomery County, and apparently about 5,000 feet above the bottom of them.



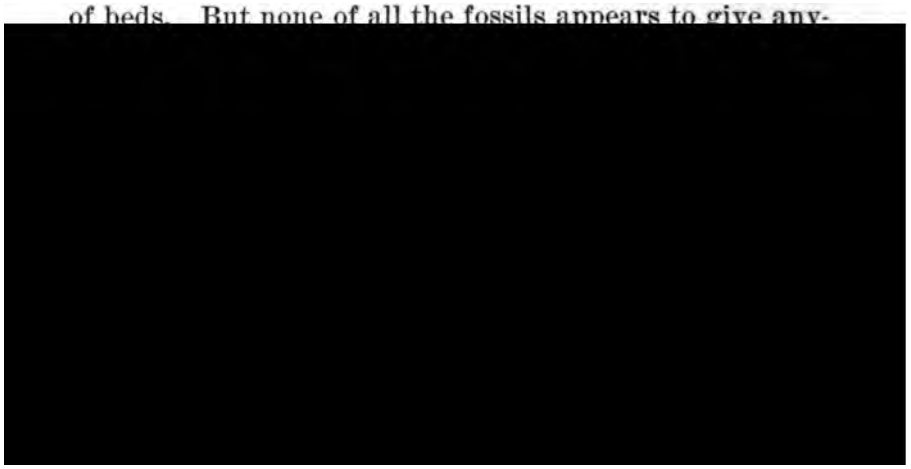
ally well marked ridge from the Delaware, near Milford, N. J., and Uhlerstown, opposite, in Bucks County, round Stony Point and Bucksville, past Ottsville, south of the Haycock Mountain, over the Perkasie tunnel, to Tylersport, and in somewhat devious course past Sumneytown and Harleysville, to Lederachsville, and thence straight, south of Shwenksville, to Sanatoga, on the Schuylkill. The individuality of the ridge is in some parts obscured by the proximity of trap hills, and by the strong curves in its own course, the occasion probably of some breaking up of the beds and of more easy crosscutting with small valleys. The roads and ploughed land over these shales are generally of a slightly greenish gray color.

The firmer character of the beds has enabled a better preservation of fossil traces; though not many have yet been discovered within the two counties. But just across the Delaware, at Smith Clark's quarry, near Milford, N. J., plant remains and tracks of reptiles, and insects have been found among the layers of these shales, and have been recorded by Newberry, four plants (U. S. Geol. Mon. XIV), H. C. Lewis, one plant (Ac. Nat. Sci. Proc. 1880), and C. H. Hitchcock, fourteen tracks, (Boston Nat. Hist. Soc. Proc. Vol. XXIV). Cook (N. J. State Geol. Report, 1879), says that though vegetable impressions are found there "in large numbers, * * * * most of them are fragmentary and indistinct," but that "they are evidently much newer than the fossils at Newark and Belleville,"—that is, some 9,000 feet geologically lower, in our Norristown shales. The plants mentioned by Newberry, few and imperfect as they were, would seem rather to show that the shales are Jurassic. No more definite indication of the age of the beds appears to have yet been found in New Jersey, and no fossils at all in this set of beds have been recorded anywhere else.

Lansdale Shales.—The next lower 4,700 feet, or so, in thickness of rock beds, are chiefly red, in great part calcareous, shales with a few scattered green layers, and with a few small rather soft red sandrock layers exposed

near the Schuylkill. The beds are mostly soft and generally do not form prominent hills; and exposures at the roadside are comparatively few, decidedly fewer than in the Pottstown Shales. The Lansdale Shales underlie a broad belt of country from Uhlerstown and Erwinna, on the Delaware, past Dublin, Telford and Souderton, and round by Hatfield, Lansdale, Kulpsville, Skippackville, Collegeville and Trappe to Royersford, on the Schuylkill; generally a region of gentle slopes, except where cut down deeply by the streams near the Delaware. There is also a small area of these shales south of New Hope, around Solebury and Jericho Mountains.

The beds are not favorable to the preservation of fossils, and scarcely any such traces have been observed within the present field. In York County, however, the Algae reported by Mr. A. Wanner, (State Geol. Report for 1887) and the tracks identified by Prof. C. H. Hitchcock (Boston Nat. Hist. Soc. Proc. XXIV), from a mile south of Goldsboro, occur perhaps towards the top of this set of beds. In New Jersey, too, one fish, at Pompton Furnace, recorded by Newberry (Mon. XIV), twelve tracks near Whitehall, identified by Prof. C. H. Hitchcock (B. N. H. Proc. XXIV), as well as plants, fishes, Estheriae and perhaps Cypris, mentioned, but not specifically, by Mr. F. L. Nason (N. J. Geol. Report, 1888), at several points, would seem probably to come from this set of beds. But none of all the fossils appears to give any-



Makefield Township on the Delaware, past Dolington, Wrightstown, Forks of the Neshaminy, up the main Neshaminy Creek to Chalfont, and then over Gwynedd tunnel and cut, and thence straight to the Phoenixville tunnels. Owing to the double occurrence of the shales towards the Delaware, in consequence of the great fault, the general form of their outcrop in this field is that of a letter Y, with the foot on the Schuylkill.

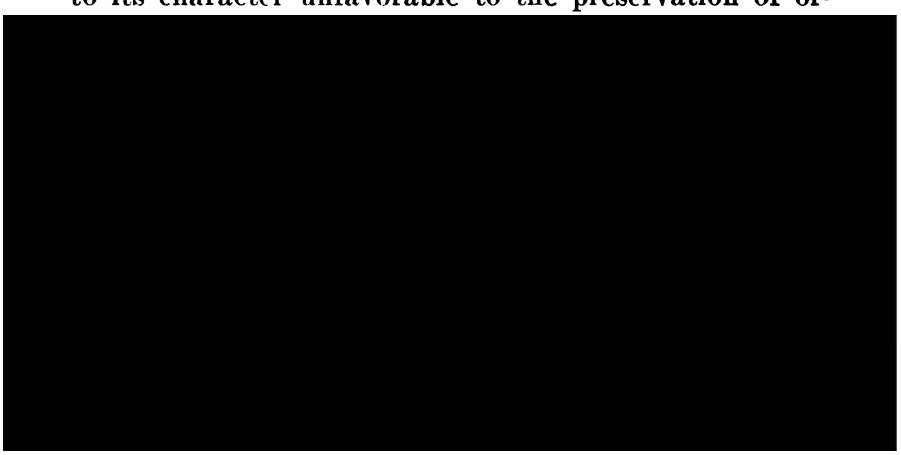
The shales are in part well fitted to preserve fossil traces, and it is from this set of beds alone that have come almost all, if not quite all, the fossils that have indicated the Rhaetic, or Triassic, or Jurassic age of the American New Red. In our field, however, few fossils have been reported; and those few from two places, each about 1,000 feet geologically below the top of the set; namely at the Gwynedd tunnel: Turseodus acutus, Eurydorus serridens (?), Cypris, and batrachian bones and teeth (Leidy, Ac. Nat. Sci. Proc. 1857 and 1859), Radiolepis speciosus, Emm. (Lea. Do. Do. 1857), Rhabdopelix longisipinis, Cope (Am. Phil. Soc. Trans., 1868); and near Yerkes Station: Radiolepis elegans, Emm. (Leidy, A. N. S. Proc. 1876). But a much larger number of species have been reported from about the same horizon at the Reading Railroad tunnel near Phoenixville, and a few from some 500 feet geologically lower at the Pennsylvania Railroad tunnel near the same town. Very many fossil plants, fishes, reptiles and tracks as well as Estheriae and Cypris have been recorded as occurring in rocks evidently of this set of beds elsewhere, particularly in the Richmond, Va., coal field and the North Carolina coal fields, as well as a very few in York county, Pa., and eastward in New Jersey, and in Connecticut and Massachusetts.

The plants seem to have given more precise indications of the age of the beds than the other fossils have. Prof. Fontaine enumerates 67 species of plants found in the Virginia and North Carolina exposures. He argues that they indicate the Rhaetic age of the beds; for 23 are near or allied to foreign Rhaetic ones, and 14 to for-

eign Jurassic ones, and the rest are peculiar to America. Four of those counted as Rhaetic are also near or allied to foreign Triassic forms. The Rhaetic is regarded as forming beds of passage between the Trias and the Lias; but in Newberry's opinion (1888) "with a still prevailing Triassic facies," though in Fontaine's (1883), "having more affinity with the Lower Lias."

Norristown Shales.—About 6,100 feet in thickness next below, and the lowest rock-beds of the whole New Red column, are mostly red partly calcareous shales, but with some important, though comparatively thin, beds of brown building stone near the top, and several thicker, coarser and even pebbly beds of light gray hard sandrock lower down. The beds, however, are mainly soft shales, and the hills formed by the harder layers are not important. The group is partially exposed on the Delaware at Lumberville, Lumberton and southward to Limeport; and runs southwestward past Doylestown to the great fault. It also appears on the Delaware near Yardleyville, and runs through Newtown and Northampton Townships to Southampton, where its lowest beds occur, and past Hartsville, Hatboro, Ambler and Fort Washington to Norristown; and beyond the Schuylkill to King of Prussia, Valley Forge and past the southern outskirts of Phoenixville.

Few fossils have been found in this set of beds, owing to its character unfavorable to the preservation of or-



tent an authority as Lesquereux, then living; but apparently that result was never reached. Mr. Paschall has a less perfect fragment ten inches long and at least six inches broad with a single joint at two inches from one end; and he says there are better specimens at the Philadelphia Academy of Natural Sciences.

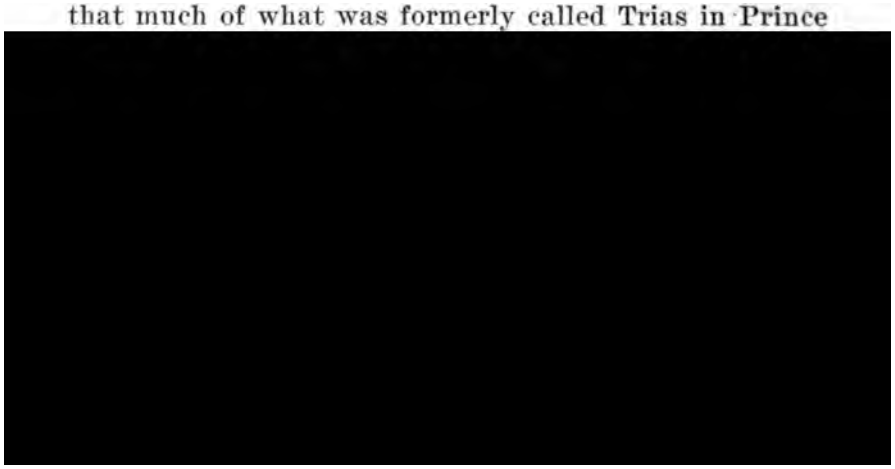
About 3,500 feet below the top of this set of shales, both at Fort Washington and below Norristown, undetermined plant fossils were found by Prof. Heilprin's geological class in the spring of 1894. Imperfect plant fossils were found during our survey at other points.

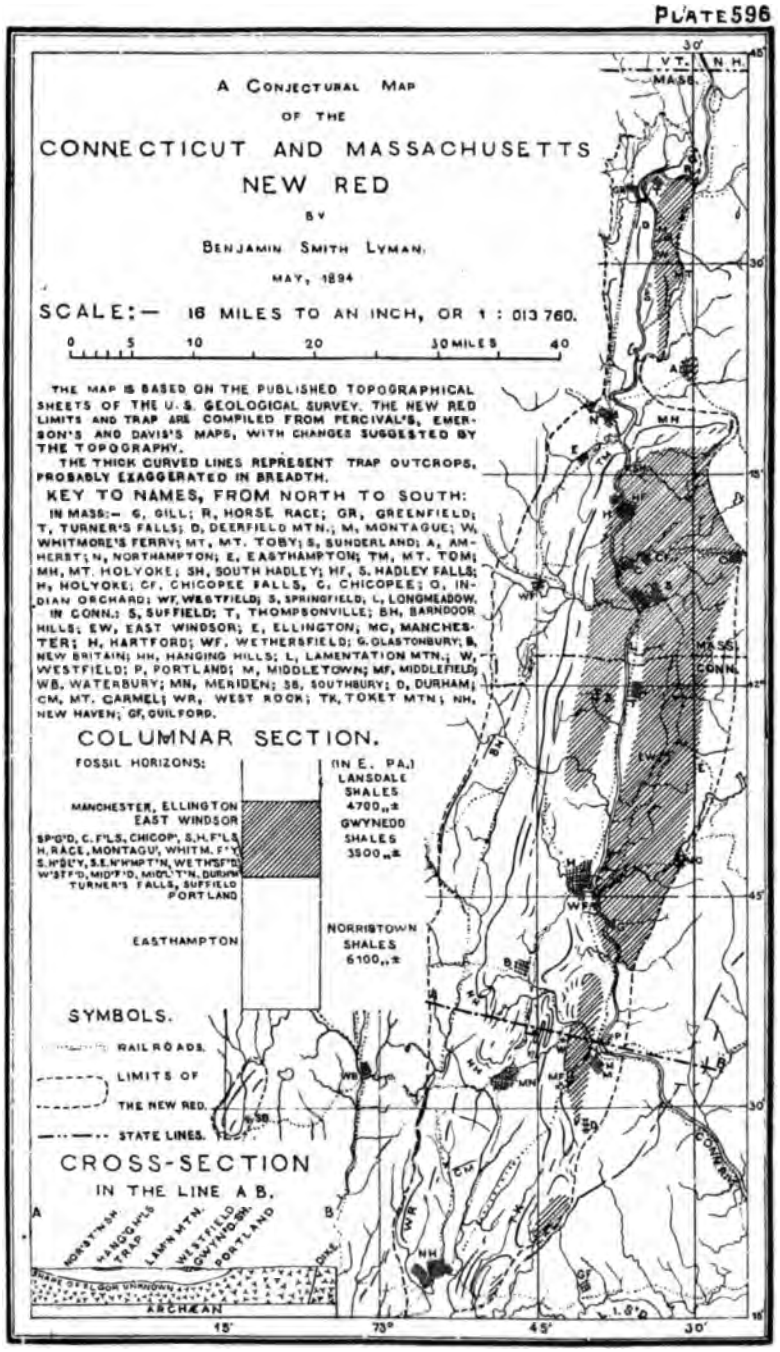
In evidently the same set of rock-beds, and near their top, at the quarries of Newark and Belleville, New Jersey, fossil plants have been found. Cook, in his New Jersey State Geological Report for 1879, says that photographs of one of them that had "a very plainly marked flattened stem" were sent to Lesquereux. That celebrated fossil botanist answered that the photographs were "sufficient at least for positive reference of the specimens to Lepidodendron;" and he was strongly inclined to identify them with L. Weltheimianum Presl., a leading species of the Old Red Sandstone and occurring from the sub-carboniferous measures down to the Devonian, while no Lepidodendron had hitherto been found as high as the upper coal measures. Newberry (Mon. XIV), speaks perhaps of the same plant when he says a fossil tree trunk often found in the Newark quarries resembles Lepidodendron, but cannot be one, because "Lepidodendron did not pass from the Carboniferous to the Mesozoic age;" evidently taking the Mesozoic age for granted in advance. The only other identified fossils from those quarries are two plants that he mentions in the same monograph: Dioonites longifolius and fragments of Clathropteris platyphylla, both found by Fontaine in the North Carolina and Virginia representatives of our Gwynedd Shales, and reckoned by him as probably nearly allied to certain plants of Jurassic age. Newberry also mentions an imperfect fossil at Newark resembling Equisetum Meriani, but too doubtful to decide

whether it is a Calamites or Equisetum or of some other genus of that family. He mentions in the same monograph a fossil plant, undistinguishable from Dendrophycus Desori Lesq., as found in the brown sandstone quarries of Portland, Ct., no doubt of the same horizon as the Newark quarries. The plant of that name, however, is found in the Mauch Chunk Shales, Pennsylvania No. XI, or Umbral Shales, quite below the coal measures.

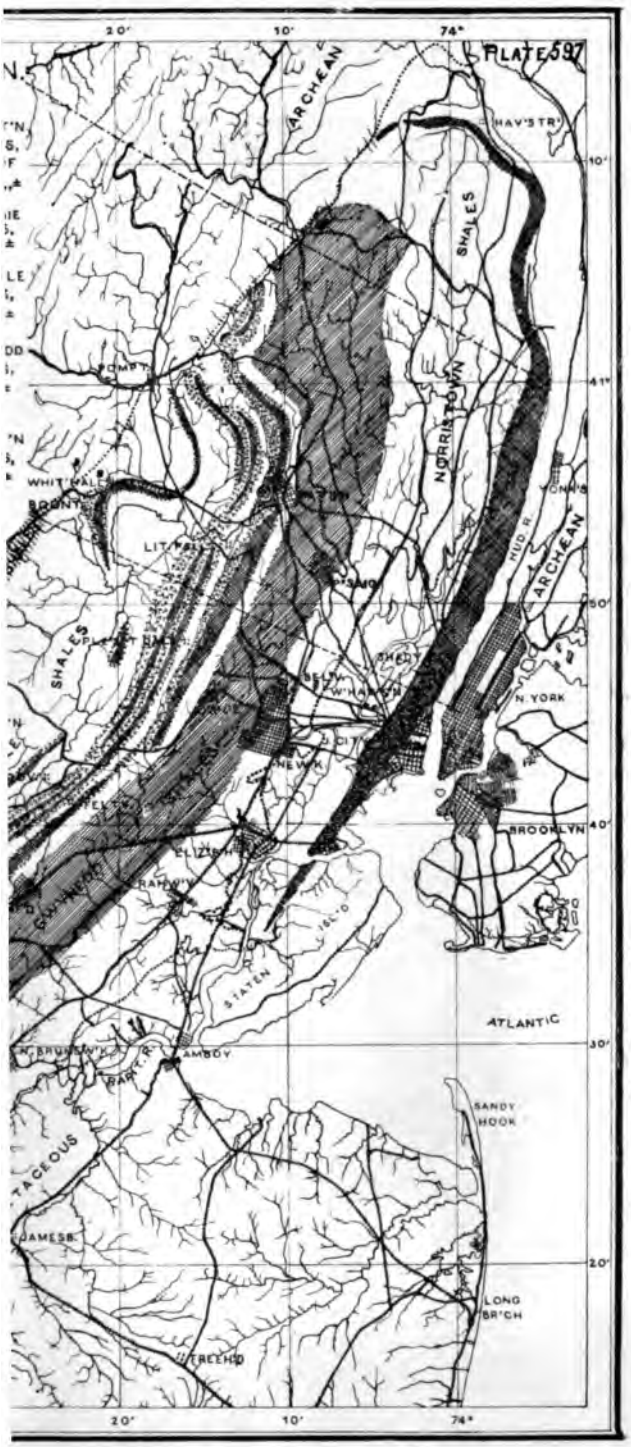
According to Newberry (Mon. XIV), the plant Clathropteris platyphylla is likewise found at Easthampton, Mass., and that must apparently be in the upper part of this set of beds. A fish fossil, his Ischypterus Braunii, was found at Weehawken, N. J., probably near the bottom of the same beds. Several Estheriae and imperfect fish and plant remains have been found at other places in New Jersey in beds most likely of the same set; and in Massachusetts and Connecticut, perhaps near the top of the set (or possibly in the Gwynedd shales) a great number of fossil foot-prints and a few unidentified plant remains have been reported by the elder Hitchcock.

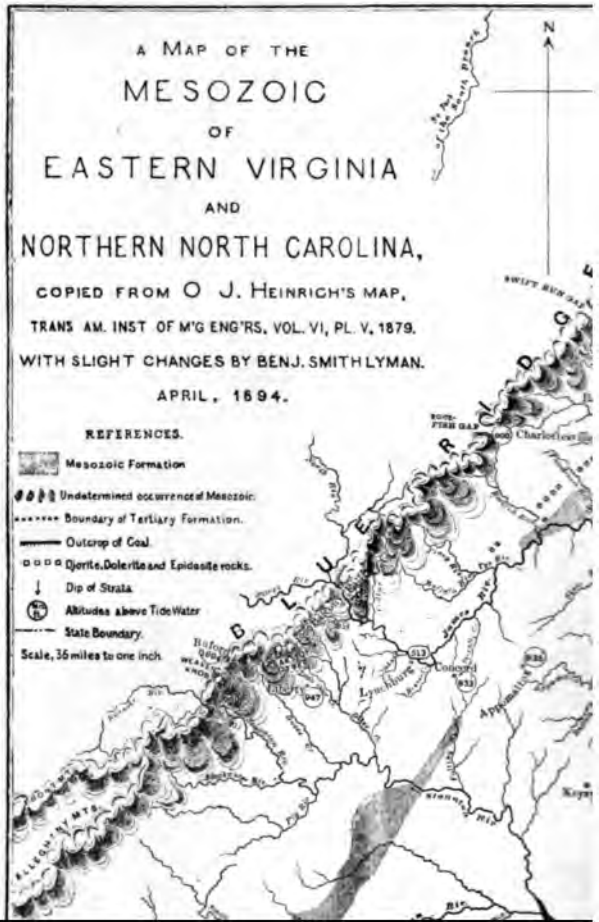
It is clear, then, that the paleontological age of this set of beds has never been satisfactorily determined; and that there is a strong probability that they are Paleozoic, at least as old as the Permian. The Canadian geologists Ells (1882-4, 1885) and Fletcher (1886, 1890-91) in the Canada Geological Survey Reports, have stated that much of what was formerly called Trias in Prince




A CONJECTURAL MAP
OF THE
CONNECTICUT AND MASSACHUSETTS
NEW RED
BY
BENJAMIN SMITH LYMAN.
MAY, 1894
SCALE:— 16 MILES TO AN INCH, OR 1 : 013 760.
0 5 10 20 30 MILES 40
THE MAP IS BASED ON THE PUBLISHED TOPOGRAPHICAL SHEETS OF THE U. S. GEOLOGICAL SURVEY. THE NEW RED LIMITS AND TRAP ARE COMPILED FROM PERCIVAL'S, EMERSON'S AND DAVIS'S MAPS, WITH CHANGES SUGGESTED BY THE TOPOGRAPHY.
THE THICK CURVED LINES REPRESENT TRAP OUTCROPS, PROBABLY EXAGGERATED IN BREADTH.
KEY TO NAMES, FROM NORTH TO SOUTH:
IN MASS:— G, GILL; R, HORSE RACE; GR, GREENFIELD; T, TURNER'S FALLS; D, DEERFIELD MTN.; M, MONTAGUE; W, WHITMORE'S FERRY; MT, MT. TOBY; S, SUNDERLAND; A, AMHERST; N, NORTHAMPTON; E, EASTHAMPTON; TM, MT. TOM; MH, MT. HOLYOKE; SH, SOUTH HADLEY; HF, S. HADLEY FALLS; H, HOLYOKE; CF, CHICOPEE FALLS; C, CHICOPEE; O, INDIAN ORCHARD; WF, WESTFIELD; S, SPRINGFIELD; L, LONGMEADOW.
IN CONN.: S, SUFFIELD; T, THOMPSONVILLE; BH, BARNDOOR HILLS; EW, EAST WINDSOR; E, ELLINGTON; MC, MANCHESTER; H, HARTFORD; WF, WETHERSFIELD; G, GLASTONBURY; B, NEW BRITAIN; HH, HANGING HILLS; L, LAMENTATION MTN.; W, WESTFIELD; P, PORTLAND; M, MIDDLETOWN; MF, MIDDLEFIELD; WB, WATERBURY; MN, MERIDEN; SB, SOUTHBURY; D, DURHAM; CM, MT. CARMEL; WR, WEST ROCK; TK, TOKET MTN; NH, NEW HAVEN; GF, GUILFORD.
COLUMNAR SECTION.
FOSSIL HORIZONS:
MANCHESTER, ELLINGTON
EAST WINDSOR
SP'G'D, C. F'LS, CHICOP', S.H. F'LS, H. RACE, MONTAGU', WHITM. F'Y, S. H'SD'Y, S.E. N'HMP'TN, WETHSF'D, W'STF'D, MIDF'D, MIDL'T'N, DURHM, TURNER'S FALLS, SUFFIELD
PORTLAND
EASTHAMPTON
(IN E. PA.)
LANSDALE SHALES 4700 ft ±
GWYNEDD SHALES 3500 ft ±
NORRISTOWN SHALES 6100 ft ±
SYMBOLS.
RAIL ROADS.
LIMITS OF THE NEW RED.
STATE LINES.
CROSS-SECTION
IN THE LINE A B.
A
B
MORY'TN SH.
HANGING HLS
TRAP
LAMPH MTN.
WESTFIELD
GWYNED SH.
PORTLAND
CONN. R.
ARCHEAN
15'
73°
45'
30'
VT.
N.H.
MASS.
CONN.


A CONJECTURAL MAP
OF THE
AMERICAN NEW RED
OF
NEW JERSEY AND NEW YORK.
BY
BENJAMIN SMITH LYMAN.
6 APRIL, 1894.
SCALE:—10 MILES TO AN INCH, OR 1: 633 600
TRAP RUBBISH.
TRAP IN PLACE.
THE MAP IS BASED ON THE N. JERSEY STATE GEOLOGICAL MAPS AND N. H. DARTON'S, WITH AID FROM THE TOPOGRAPHY. THE GEOLOGICAL STRUCTURE IS ESPECIALLY CONJECTURAL FOR A DOZEN MILES NORTH, WEST AND SOUTH OF SOMERVILLE; BUT ELSEWHERE SEEMS CLEAR, THOUGH THE LIMITS OF THE ROCK GROUPS ARE NOT PRECISELY KNOWN.
CROSS-SECTION
FROM BOONTON TO NEW YORK CITY.
COLUMNAR
FOSSIL HORIZONS:
N. VERNON
MILFORD, BOONTON
POMPTON
WHITEHALL, N. PROV.
PLUCMIN, MARTINSV.
HARNV., WASH'N, FELTV.
TUMBLE
WASH'N'S CROS'G
FLINESVILLE
NEWARK, BELLEVILLE
WILBURTHA
SHADY SIDE
AND WEEHAWKEN
PALEOZOIC
AND
ARCHEAN
PHILLIPSB'G
EASTON
PLUCKEMIN


PLATE 597
20'
10'
74°
ARCHEAN
HAV'S TR'
SHALES
NORRISTOWN
HUD. R.
ARCHEAN
SHALES
N. YORK
BROOKLYN
ATLANTIC
SANDY HOOK
LONG BR'CH
STATEN
AMBOY
TRENTON
40'
30'
20'


A MAP OF THE
MESOZOIC
OF
EASTERN VIRGINIA
AND
NORTHERN NORTH CAROLINA,
COPIED FROM O J. HEINRICH'S MAP,
TRANS AM. INST OF M'G ENG'RS, VOL. VI, PL. V, 1879.
WITH SLIGHT CHANGES BY BENJ. SMITH LYMAN.
APRIL, 1894.
REFERENCES.
Mesozoic Formation
Undetermined occurrence of Mesozoic
Boundary of Tertiary Formation.
Outcrop of Coal.
Gjerite, Dolerite and Epidosite rocks.
Dip of Strata.
Altitudes above Tide Water
State Boundary.
Scale, 35 miles to one inch.
N
BLUE RIDGE
Charlestown
Concord
Appalachian



NOTE BY B S L — FROM THIS MAP AND PROF. NTAINE'S ACCOUNT THE RICHMOND AND THE EP RIVER COALS WOULD SEEM TO BE OF THE ME HORIZON, AND THE FARMVILLE AND DAN ER COALS ALSO OF THE SAME; AND ALL TO LONG TO THE GWYNEDD SHALES. THE NORTH- STERN AREAS, NEXT THE BLUE RIDGE, SEEM BE LATER, AND TO CONTAIN THE PERKASIE ALES. THE NORRISTOWN SHALES MAY OCCUR THE EASTERNMOST AREAS.

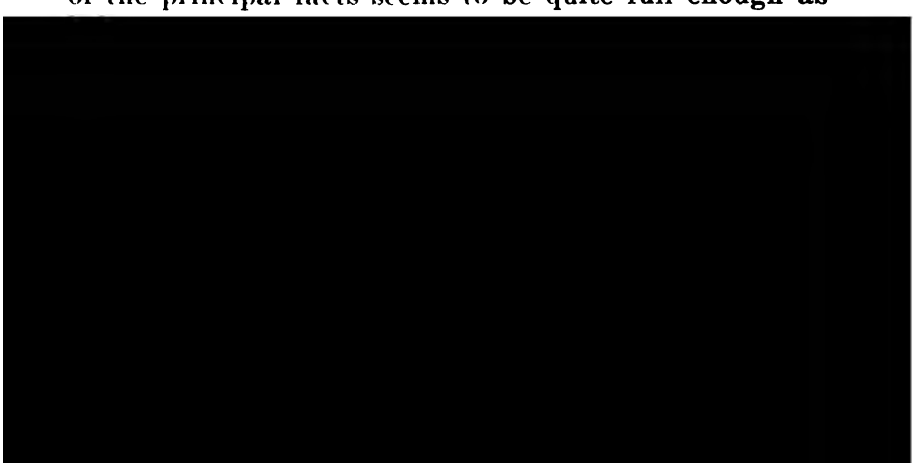
West Virginia and southwestern Pennsylvania (Pa. State Geol. Report PP, 1880), as Prof. J. J. Stevenson's researches (Report K, 1876) had already made probable and as Rogers (1858) had suspected to be not unlikely. Lithologically there would seem to be much resemblance between those Permian beds and the Norristown shales, a confirmation, to some extent, of the hitherto scanty indications of our eastern fossils.

It is probable, therefore, that not all of our New Red can be reckoned as Mesozoic, and the age of at least its upper half is from the rarity of reported fossils extremely obscure. The great thickness of the whole series then, is not in the least inconsistent with any known paleontological observation and is consequently no longer a mystery that stands in need of explanation or of disproof, or at least of discredit by means of violent hypotheses.

Nor in the New Red fields of other states is there anything that does not readily harmonize with the results of our two counties. In the Proceedings of the American Philosophical Society, Vol. XXXIII, 1894, pp. 192-215, it is shown with three maps, here reproduced (Massachusetts and Connecticut on one map, Pl. 596, New York and New Jersey on another, Pl. 597, and Virginia and North Carolina on the third, Pl. 598), how our five subdivisions of the whole series may be traced with some probability in the other states by means of observations previously published, particularly by Hitchcock, Percival, Cook and F. L. Nason in the Massachusetts, Connecticut and New Jersey State Geological Reports, and by Prof. Davis, I. C. Russell, N. H. Darton, W. B. Rogers, O. J. Heinrich and Prof. W. M. Fontaine in their well known very valuable memoirs. And especially help is received from the New Jersey and United States Geological Surveys' topographical maps, throughout New Jersey and Connecticut and Massachusetts, as well as, in Virginia and North Carolina, from O. J. Heinrich's map (copied, Maj. Jed. Hotchkiss says, from Wm. B. Rogers' map published by Hotchkiss in 1876). It is pointed out (p. 215)

"that although the New Red beds do not everywhere exist in the same completeness as in Montgomery county, yet certain portions are pretty fully represented in distant states, the lower third in Connecticut, the lower half in northeastern New Jersey, and the lower portions and upper portions in separate basins in Virginia."

In addition to the facts given here and on the map and cross-sections in ample demonstration, as it seems, of the thickness of the whole series of beds and of the five sub-divisions, still much fuller details of the character of the observed beds have been set forth in the couple of thousand columnar sections of exposures already spoken of as drawn to one uniform scale. In connection with them, fifty township contour-line maps on a uniform scale, covering the whole field, have been drawn, for the purpose of displaying separately the geology of each township with every observed exposure to be marked on the map and with every section to be described in full in the text of a special report on each township. Several such reports were written. But it has seemed on the whole unnecessary at present to undertake so much additional expense as the completion and publication of all that work would require; especially as the survey has already cost (not to the State, but privately) several times as much time and labor as any one dreamed of at the outset. The demonstration of the principal facts seems to be quite full enough as

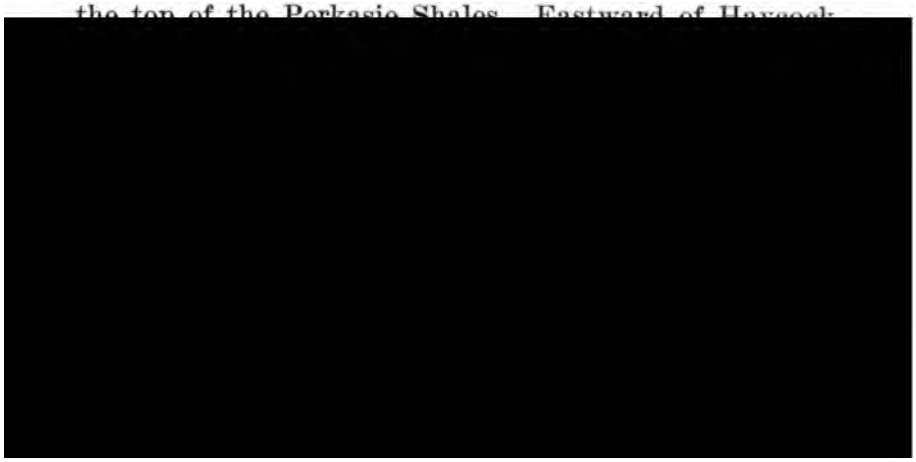


and decomposed trap earth. But it appears from the comparatively narrow limits of the solid trap where streams have cut across it and carried away the superficial loose material, so as to leave the sedimentary shales exposed, that the solid trap deposits are generally much less wide than the superficial outspread of broken and decomposed trap material or rubbish. As the greater hardness of the trap has enabled it to resist erosion more successfully than the shales could do, it tends to stand out in the form of hills above the shales. It is safe, then, to take the shape of the hills as to some extent a very useful guide to an estimate of the breadth of the underlying solid trap; and to consider that at the side of it more or less ground may be covered by trap rubbish that has either been spread there through rolling or sliding down from the adjacent trap ridges or through getting washed there by the eroding waters, or through being simply left lying there after the erosion of once overlying beds of solid trap. It is perhaps rather to be wondered at that there is not even a greater quantity of such scattered rubbish remaining over a still wider extent of country, considering the great hardness of the trap. We should, however, consider, not merely its hardness when fresh, but its liability to decompose and soften in geological ages, owing to the comparative instability of some of its constituent minerals. This feature of the trap is shown very well in the exposure of the dike on the Trenton Cut-off Railroad presently to be described and illustrated with Plate 599. The dike, although 25 yards across makes very little show on the surface of the ground; and it is seen that about two-thirds of the breadth of the dike is completely decomposed down to the level of the railroad, and the whole to the depth of a dozen feet or more from the surface. Plainly some parts have decomposed more readily and thoroughly than others, so that only here and there along the outcrop of the dike undecomposed blocks occur on the ground. Evidently the traps of our field are much more readily decomposable, and for that reason

make much less show at the outcrop, than the very conspicuous dike of Cumberland and Perry Counties, crossing the Blue Mountain and forming a ridge fifty feet high.

As for solid trap in place, there are extremely few points, perhaps hardly half a dozen, in the two counties where it is to be actually seen. Everywhere else it is merely the trap rubbish, either bowlders, in many places so numerous as to cover the whole ground, and sometimes as large as small houses, or still more universally the peculiar yellowish gray loam of fully decomposed trap, always accompanied by larger or smaller blocks. On the printed map the spaces supposed to be underlain by solid trap are indicated with a full color, and those that are merely more or less covered by trap rubbish are given with scattered dots of the same color. In some cases there appear to be two or three distinct deposits of trap, where the surface of the ground is covered by one single outspread of the trap rubbish; and it is quite possible that in many other places there are interbedded shales now completely covered by the broad blanket of decomposed trap.

It is seen on the map that the largest trap deposit is at Haycock Mountain and thence growing narrower southwestward to Sumneytown, with a decided bend northwestward at the boundary between the two counties; following everywhere one geological horizon near the top of the Perkasie Shales. Eastward of Haycock



trap rubbish that is perhaps partly supplied by some underlying hidden masses of solid trap of the horizon just referred to, besides the main trap of the mountain. Near Sumneytown a long trap deposit begins at a little higher horizon in the lower part of the Pottstown Shales, and with a very crooked course conformably to the shales extends past Perkiomenville, Zieglersville and north of Shwenksville nearly to Sanatoga. Three other masses of somewhat higher horizons continue the hill westward to the county line, north of Pottstown; three separate masses apparently, though the whole space above and between them is covered with trap rubbish. The three seem to correspond with other masses at the same horizons on the north side of the Boyertown basin; and again north of the next basin, north of East Greenville; and the two upper ones yet once more north of Quakertown and near Coopersburg, Lehigh County. Two or three other horizons in the Pottstown Shales have very small trap masses near the northwestern edge of the field.

South of the Paleozoic "island," the Norristown shales have a small trap mass just across the Delaware north of New Hope and Lambertville. A mile and a half southwest of that trap and within the limits of the Paleozoic limestone of Solebury Township there are two small trap dikes visible in place, at W. L. Ely's (formerly D. Ely's) quarry. One is about three feet wide and has a dip of 55 degrees south 75 degrees east; and the other is about 7 feet wide and runs north 10 degrees west with a steeper dip. No trap has been found in the Lansdale Shales northwest of the Paleozoic "island;" but south of it there is a somewhat important mass at Solebury Mountain near their top, and another at Jericho Mountain and Bowman's Hill, about their middle, and apparently in striking conformity to the very much twisted condition of the shales.

In the lower part of the Gwynedd Shales, just below Pt. Pleasant, on the Delaware, there is a trap mass of comparatively small thickness that seems to conform to

the shales and to extend a mile southwestward from the river, and to be bordered by trap rubbish two miles further. Indeed, with some gaps the trap blocks and rubbish, in great part very scantily, extend nearly nine miles from the river along the outcrop of the same horizon; and then after another short gap are continued by trap rubbish, across the strike of the shales, two or three miles further to the great fault near Chalfont. South of the fault there seems to be no continuation of this trap or trap rubbish; but four miles eastward and more than two miles south of the fault, and directly south of Doylestown, begins a space sparsely covered with trap rubbish that extends south, across the strike of the shales, five miles to Horshamville. Thence southwestward past Dreshertown to the edge of the field there are four very small patches of trap rubbish; and by an oversight a couple of others were omitted from the map, all nearly in the same straight line.

An exposure of a trap dike near by has also been observed on the new Trenton Cut-off Railroad since the map was printed. The dike is 25 yards wide, runs north about 30 degrees east, and dips 75 degrees northwesterly. The accompanying Plate 599 shows all the known occurrences of trap in that neighborhood, as well as a correction of the southern limit of the New Red. The precise limit is the more obscure from the occurrence of much red quartz in the neighboring Paleozoic rocks, and from

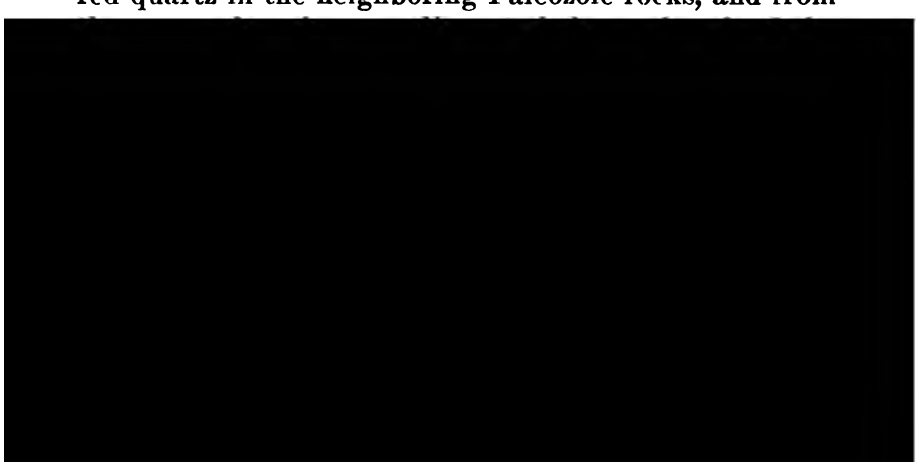
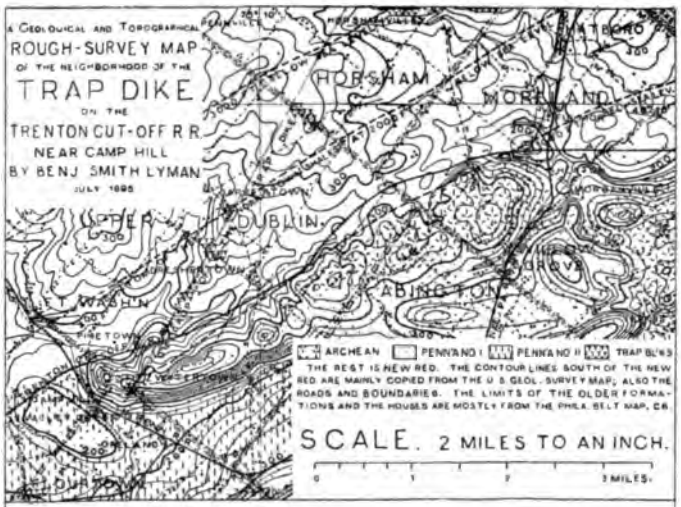
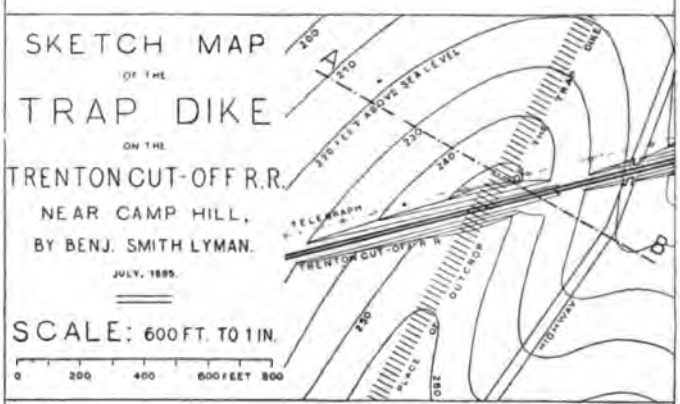
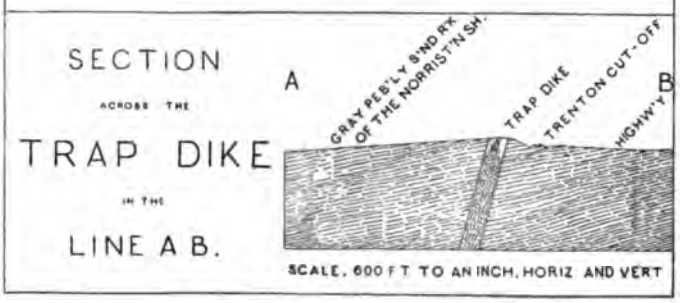


PLATE 599


A GEOLOGICAL AND TOPOGRAPHICAL
ROUGH-SURVEY MAP
OF THE NEIGHBORHOOD OF THE
TRAP DIKE
ON THE
TRENTON CUT-OFF R.R.
NEAR CAMP HILL
BY BENJ. SMITH LYMAN
JULY 1895
HORSHAM
MORELAND
UPPER DUBLIN
ABINGTON
ARCHEAN
PENN'A NO I
PENN'A NO II
TRAP DIKES
THE REST IS NEW RED. THE CONTOUR LINES SOUTH OF THE NEW RED ARE MAINLY COPIED FROM THE U. S. GEOL. SURVEY MAP, ALSO THE ROADS AND BOUNDARIES. THE LIMITS OF THE OLDER FORMATIONS AND THE HOUSES ARE MOSTLY FROM THE PHILA. SELT MAP, Ed.
SCALE. 2 MILES TO AN INCH.
0
1
2
3 MILES.


SKETCH MAP
OF THE
TRAP DIKE
ON THE
TRENTON CUT-OFF R.R.
NEAR CAMP HILL,
BY BENJ. SMITH LYMAN.
JULY, 1895.
SCALE: 600 FT. TO 1 IN.
0
200
400
600 FEET
800
A
B
200
210
220
230
240
250
260
270 FEET ABOVE SEA LEVEL
TRAP DIKE
TRENTON CUT-OFF R.R.
OUTCROP
HIGHWAY


SECTION
ACROSS THE
TRAP DIKE
IN THE
LINE A B.
A
B
GRAY PEB'LY B'ND RK. OF THE NORRIST'N SH.
TRAP DIKE
TRENTON CUT-OFF
HIGHW'Y
SCALE. 600 FT TO AN INCH. HORIZ AND VERT

exactly on a prolongation of the line of the Conshohocken-Flourtown dike.

It is evident that almost all the solid, undisturbed trap in the whole northwestern half of the field and in the part just south of the Paleozoic "island" occurs in the form of sheets or beds conformable to the sedimentary rocks. It was formerly supposed by Rogers and others that such sheets, as well as all other solid trap, were dikes, and that they had forced their way intrusively between the beds, in some cases to immense distances, without essential departure from a single bedding plane, even in comparatively soft shales. Hitchcock long ago showed that such a conformable sheet of trap was not always intrusive, but an overflow contemporaneous with the sedimentary beds; that is, that it had flowed over the still level surface of the underlying sedimentary beds before the deposition of the overlying ones. Prof. Davis has done yeoman's service in proving that it is so with many trap-sheets that were formerly called intrusive; and his demonstrations in regard to the trap-sheets of the Connecticut Valley and New Jersey have been very useful in our two counties, where opportunities of observing the trap in place are so exceedingly rare. Even he, however, was perhaps not always exacting enough in requiring proof of the intrusive character of the trap; since he admitted that the great trap-sheet of the Hudson River Palisades was intrusive, for reasons apparently not completely cogent. The out-crop of that sheet is over fifty miles long and extremely crooked, but as our little map shows, evidently conformable in the most striking manner to the geological structure of the sedimentary rocks through the whole northern part of the New Jersey Red field. It would need thoroughly invincible arguments, strong beyond a shadow of doubt, to persuade one that such a sheet was not an overflow.

In our two counties, at all events, there would seem to be no good reason whatever for considering the conformable trap-sheets anything but overflows, and any other supposition would now seem very strained. We may

safely reckon, then, as overflow sheets almost all the traps of the northwestern half of the field, that is the trap of Haycock Mountain, and those of about the same horizon eastward to the Delaware, and those a little later southwestward towards Pottstown and northwestward to the county lines; and also, southward, the small deposit near Point Pleasant, and the larger ones of Solebury Mountain and of Jericho Mountain and Bowman's Hill. Nevertheless, in all these numerous and widespaces the only place where the contact of the trap with the overlying or underlying shales could be seen, so as to confirm the overflow character by a direct observation of that kind, was in the railroad cut a mile and a half south of Quakertown; and there the shales below a very uniform twenty-foot bed of trap seem to have been baked, but the ones above to have been unaffected.

Several other deposits, however, are clearly dikes, as shown by their cutting across the strike of the sedimentary beds in the way already noted. An observation of trap in place, on the west bank of the Perkiomen Creek at Perkiomenville seemed at first sight to make the trap appear conformable to the adjacent shales with a nearly vertical southwesterly dip; but it was doubtless only a conformity of cleavage planes of both the trap and shales, though the shales have bands of somewhat different colors parallel to those planes. The trap here



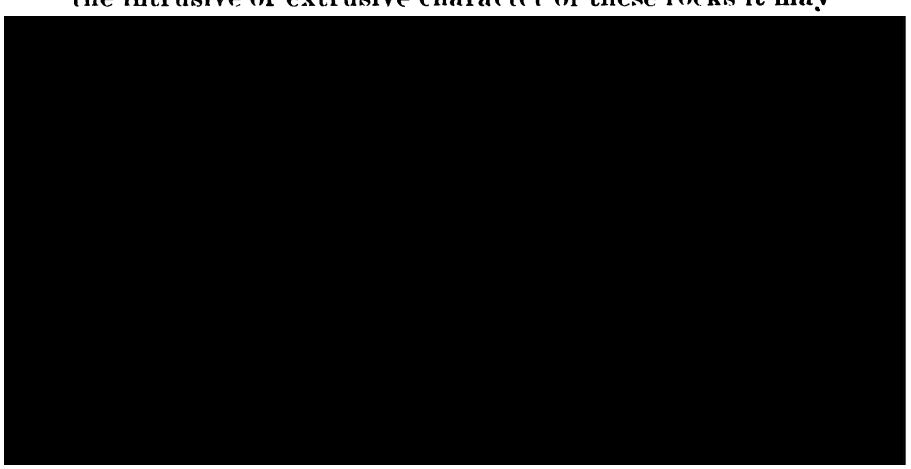
sources or original dikes of the northern trap beds have not been observed elsewhere. At several places in the southern part of our field (besides Ely's quarry and the Trenton Cut-off already mentioned), dikes appear to exist; although no overflow sheet is now connected with them, because their overflows, as well as the sedimentary beds that formerly underlay them, have been completely eroded away. All the patches of trap rubbish that have been mentioned southward from Point Pleasant were regarded by the late Prof. H. Carvill Lewis as evidence of a great trap dike running through that part of the country, broken by the great fault with a heave of four or five miles (Am. Phil. Soc. Proc. Vol. XXII, 1885). On closer examination, it would seem, rather, that the patches of rubbish that cross the strike are evidence of the existence of a number of smaller discontinuous dikes.

Age.—It appears then that most of the trap occurs in the form of overflow sheets laid down during the deposition of the Pottstown Shales, and especially one large mass, that of Haycock Mountain, slightly earlier near the top of the Perkasie Shales. During the time of forming the Lansdale Shales, trap flowed upon them, in these counties, only near the Delaware, at Solebury and Jericho Mountains, and not very extensively there. The only earlier contemporaneous deposit of trap was the small one in the Gwynedd Shales near Point Pleasant. In New Jersey, however, a very large trap overflow seems to have occurred near the beginning of the Norristown Shales; and in the Connecticut Valley, the time of igneous activity was apparently likewise during the period of the Norristown Shales, and almost solely then, though not at their very beginning. The occasion of the great outflows of igneous rock would therefore seem not to be the pressure downwards of the great load of New Red rocks, with the fissures thereby opened, as it might possibly have been inferred to be if only our two counties were regarded.

Lithology.—Prof. Amos P. Brown, Ph. D., has, at my

desire, very kindly contributed the following brief account of the lithology of the trap of the two counties, a subject he has lately been investigating with great ability:

"Notwithstanding their wide distribution and apparent differences in age the trap rocks of the Mesozoic area in Bucks and Montgomery Counties are remarkably similar in structure and lithological composition. Quite as marked variations may often be detected in these rocks from one continuous deposit as would be found by comparing those from isolated occurrences in this area. But four species of rocks are represented and these have nearly the same minute structure and are genetically connected. They are all plagioclastic rocks, and contain in addition to the plagioclase either a pyroxene or a hornblende, and generally titanic magnetite. The four species distinguished are diabase, dolerite, gabbro and epidiorite. The structure in all approximates what is called ophitic, the rock consisting of more or less distinct lath-shaped plagioclase cystals mixed with granular or less perfectly crystallized pyroxene or hornblende and granular titanic iron. The diabase and dolerite may be considered the original rocks, the gabbro and epidiorite being derived from them by metamorphic action. Without entering into the question of the intrusive or extrusive character of these rocks it may



position, but contains much titanic iron in addition to the plagioclase and augite, and often, too, contains olivine. Such rocks as those in the Conshohocken dike are of this character, or that in the deposit south of Point Pleasant on the Delaware. In this dolerite where the magnetite is present in considerable amount it is often associated with sphene.

"Gabbro.—By far the greater part of these traps are gabbro, and have resulted from the alteration of the diabase in most cases, less frequently from alteration of the dolerite. Gabbro consists of diallage and more or less saussuritized plagioclase. The diallage is a pyroxene with a strong orthopinacoidal parting, and is derived from the original augite. In addition to these two constituents, titanic iron and sphene may also be present. These gabbro vary much in color according to the proportion of diallage present or the size of the grain, the finer grained rocks being dark grey to nearly black, while the coarse rocks may be light grey. All stages of alteration from the original diabase or dolerite to this gabbro may be traced in these rocks, and they also grade insensibly into the final stage in the alteration, the epidiorite. This gabbro is typically developed at Rockhill Station, and also at Shelly Station on the N. P. R. R., near both of which places it is worked for paving block, but quite as characteristic occurrences are to be seen on Solebury Mountain, or the Haycock or in the "Swamp."

"Epidiorite.—This consists of saussuritized plagioclase, hornblende, paramorphs after augite and magnetite. The saussurite is generally the augite-zoisite, mixture. In the change of the augite into diallage, and finally into hornblende, much magnetite is set free in small octahedral cystals. The titanic iron when present alters usually in great part into sphene.

"This rock, on account of the presence of the hornblende is generally of a greenish color and is more tough and difficult to break than the gabbro. It can hardly

be worked into square blocks like the gabbro. A very typical occurrence of it is at Jericho Mountain which consists largely of epidiorite, and the basal portion of the traps near Coopersburg and New Hope are this same rock.

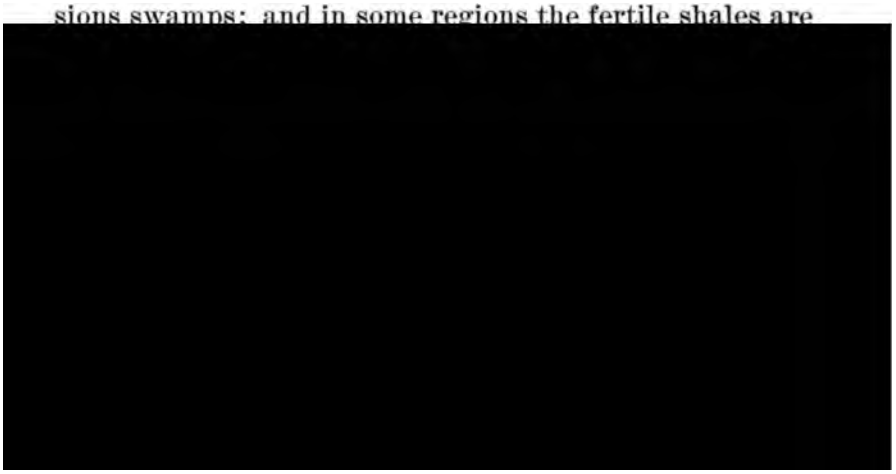
"Chemical analyses of many of these rocks are given in Survey Report C 6, to which reference may be made."

ECONOMIC GEOLOGY.

The economic geology of the two counties is much less important than it is in some parts of the State; yet the field is not wholly lacking in very useful minerals, nor, on the other hand, in enticements to waste much money in fruitless mining if the subject be not well investigated.

Soil.

The prevalent red beds of the Pottstown Shales, the Lansdale Shales and the Norristown Shales, are generally somewhat calcareous, and form in decomposing at the outcrop a very fertile soil. Accordingly the colors that indicate those shales on the map show also where the land is mainly good for farming. Of course, something depends, too, upon the configuration of the surface of the ground, as shown by the contour lines, whether comparatively level or rough with hills. In some places the surface is too flat to be readily drained, and occasions swamps; and in some regions the fertile shales are



ships and elsewhere; but commonly the trap earth is too much encumbered with trap bowlders to be easily cultivated, and it is most often left to be covered by forests.

Building Stone.

The most valuable mineral deposits beneath the soil of the counties are the building stone.

The brown sandstone much used for buildings in Philadelphia and elsewhere comes from a couple of thirty-foot beds at about 150 feet and 350 feet below the top of the Norristown Shales. The quarries are at Yardleyville (Kirkman's, Nickleson's, Anderson's) at Newtown (Mitchell's), at Grenoble Station on the Northeast Penn. R. R., and near it; and near the Perkiomen Stone Co.'s quarry, above Valley Forge, on the Schuylkill, though not so celebrated here for its ornamental quality. The same beds, too, appear to be partly exposed back of Lumberville and near Gardenville, and north of the Little Neshaminy near Jacksonville. No doubt they could be opened at many other points where favorable to railroad or river or canal carriage and to easy stripping of the surface covering. Yet the quality near the Schuylkill is likely to prove not equal for fine building work to what it is at Newtown and Yardleyville. The probable place of outcrop of both beds of building stone is marked throughout on the map by dotted lines; so that the beds can easily be tested wherever the stripping conditions indicated by the contour lines and by the dip are favorable.

The next lower, gray, somewhat pebbly sandstone in the Norristown Shales are strong and, though less easily worked, are serviceable for bridge piers, cellar walls and foundations generally. On the canal below Yardleyville, and on the Neshaminy below Newtown, they were formerly quarried; and they are extensively quarried above Norristown along the railroads on both sides of the Schuylkill; and they are also quarried near Lumberton. The outcrop of these beds can also be found without

great difficulty by their distance from the two beds of brownstone already mentioned.

The yet lower, more pebbly sandstones have likewise been a good deal quarried below Yardleyville for foundation walls; and still are so to some extent.

The trap is a very strong, durable building stone; but is rather hard to work, and is of sombre color. Of course, it would be excellent for foundations or for bridgepiers.

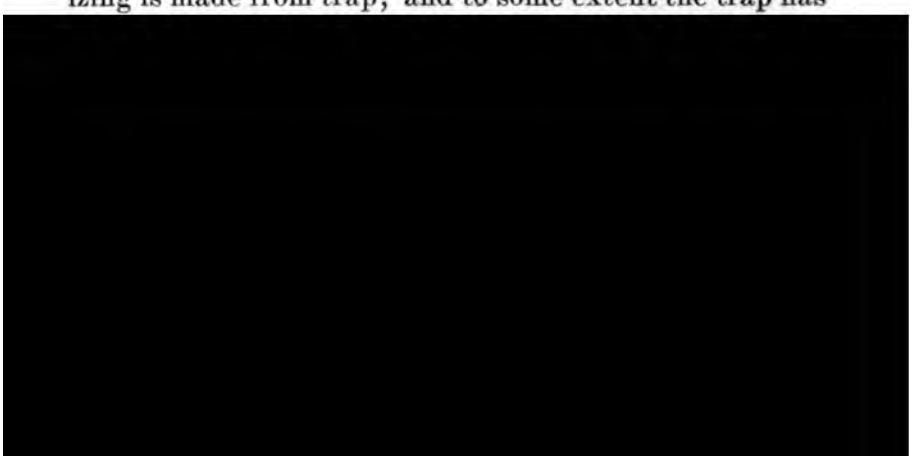
Paving Stones.

Paving-stones of excellent quality are made from the trap at several points, chiefly from the trap bowlders. The principal quarries of that kind are near Rockhill and Shelly Stations, on the Bethlehem line of railroad, and at Spring Mount on the Perkiomen Railroad, and near Perkiomenville. The trap is very well suited for the purpose; and evidently it could so be utilized at many other points where railroad or canal carriage is favorable.

The gray sandstone about 1,000 feet below the top of the Norristown Shales is quarried for paving stones at Lumberton in Kimball's quarries.

Road-Metal.

Road-metal of excellent durable quality for macadamizing is made from trap; and to some extent the trap has



any such outlay. It is true that near Richmond, Va., and in North Carolina, workable beds of coal occur in rocks apparently of the same age as our Gwynedd Shales; but in these two counties there can be no reasonable hope of finding any workable bed of coal. Such a bed with its outcrops necessarily many miles in length, if nowhere completely exposed, would at least have occasioned many striking indications that would be sure to have been discovered long ago by the very observant inhabitants of the country; and they have, indeed, made expensive trial of several thin coal layers and of black-shale-beds that any geologist would have known to be valueless.

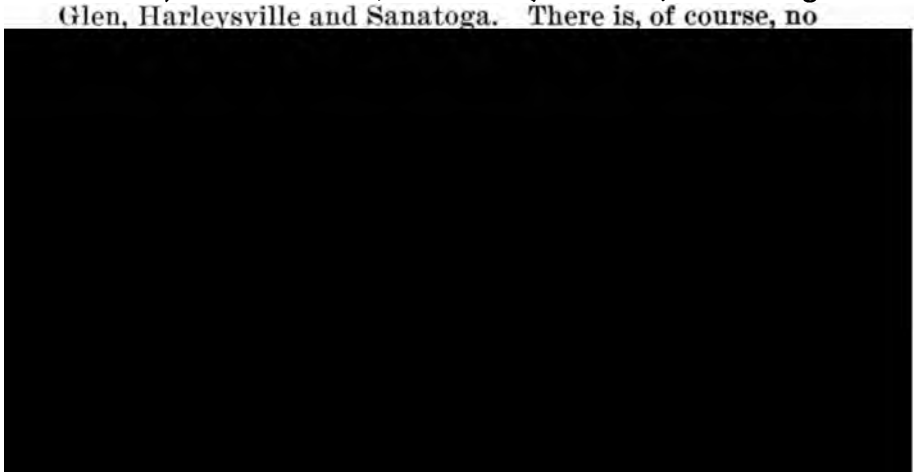
At Dark Hollow, near the Little Neshaminy, in Warwick Township, a few inches of coal were found in the dark Gwynedd Shales, and were drifted upon many years ago for a number of yards; but it was found not to exceed perhaps two or three inches in thickness, and was of course wholly unworkable. On the North Branch of the Neshaminy in New Britain Township, coal was said in the newspapers to have been found in August, 1893; evidently in the same Gwynedd Shales, and no doubt equally delusive.

Prof. Oscar C. S. Carter has called attention (Franklin Institute Journal, Aug., 1894), to another point in the Gwynedd Shales, on the Shirley Farm, at Arcola Station, on Perkiomen Creek (near the mouth of Skippack Creek, where the newspapers had asserted that a vein of anthracite coal 26 inches thick had been opened. On visiting the place, however, he found the pit inaccessible, but the coal was said to vary from 26 inches to one inch in thickness. Some coal that seemed to have been thrown out from the hole proved on his assaying it to be anthracite, partly of excellent quality. The existence of anthracite in these beds, however, at a place so remote from any igneous rocks that might have produced anthracite from bituminous coal, would be so improbable that it needs the strongest possible evidence by a perfectly trustworthy unbiassed observer that he has

actually seen it in place before it was dug from the rock-beds. But even a bed of it of that small and variable thickness would be insufficient encouragement to working it.

Prof. Carter also mentions coal three inches thick half a mile west of the Trooper Tavern, in Lower Providence Township, Montgomery County; black coaly shales at Gwynedd; coal in a bored well at North Wales; coaly slate in a bored well on the Duffield farm, between Custer and Belfry stations, on the Stony Creek R. R., Worcester Township; and two inches of coal in the Pennsylvania Railroad tunnel near Phoenixville; all of them plainly in the Gwynedd shales. Again, he speaks of coal found in a deep bored well at Lansdale, evidently in the Lansdale Shales, and an inch of coal at Norristown, clearly in the Norristown Shales, a couple of thousand feet below the top. At about the same horizon, a still thinner carbonaceous layer, or even coal, of scanty extent, perhaps remains of a single tree, was observed in a quarry near Yardleyville on the Delaware.

Several layers of the Perkasie Shales are quite blackish and have occasioned some unrewarded outlay in the search for coal. Such layers have been particularly noticed by the roadside near Rufe's Corner and at the Revere boring (see Am. Phil. Soc. Proc. Vol. XXIX, 1891), both in Nockamixon Township; also on the McDevitt farm, near Ottsville; and near Perkasie, Blooming Glen, Harleysville and Sanatoga. There is, of course, no



LEAD, ZINC AND COPPER.

Doan's mine, at New Galena, on the North Branch of the Neshaminy, in New Britain Township, three miles and a half northwest of Doylestown, was opened about 1863, was worked a little as late as 1888, and according to a newspaper account was about to be reopened in 1891, to be worked six months under an option to purchase in case the vein of ore should be found to be twelve inches wide. When visited in 1889, the mine was a hole some fifty yards long by twenty yards wide, full of water and quite inaccessible. It is said to be fifty feet deep. The dump showed very little galena indeed, much quartz, specks of copper pyrites, traces of malachite and a little zinc blende. The country rock appears to be blackish gray hard shales. It is not at all probable that any workable vein exists here. The mine is geologically about 800 feet above the bottom of the Gwynedd Shales.

The Perkiomen Lead and Copper Mines, and the Ecton Mines, near together, a mile east of Oaks Station and a half mile northwest of Shannonville, in Lower Providence Township, are said to have been opened about 1850 and abandoned before 1870, and are now quite inaccessible. The old dumps have still some specimens of ore: at the Perkiomen Mines, chiefly quartz, a little copper pyrites and traces of malachite, with light reddish gray coarse sand-rock as the country rock, and without any galena or blende observed by us; and at the Ecton Mines, quartz, blende and galena, with only traces of copper pyrites, and with country rock perhaps like that of the Perkiomen Mines, but possibly dark red, coarse, rather sandy micaceous shale. The mines at both places are geologically about 400 feet above the bottom of the Gwynedd Shales. It cannot be doubted that they were judiciously abandoned, as lacking any veins that could be worked with profit.

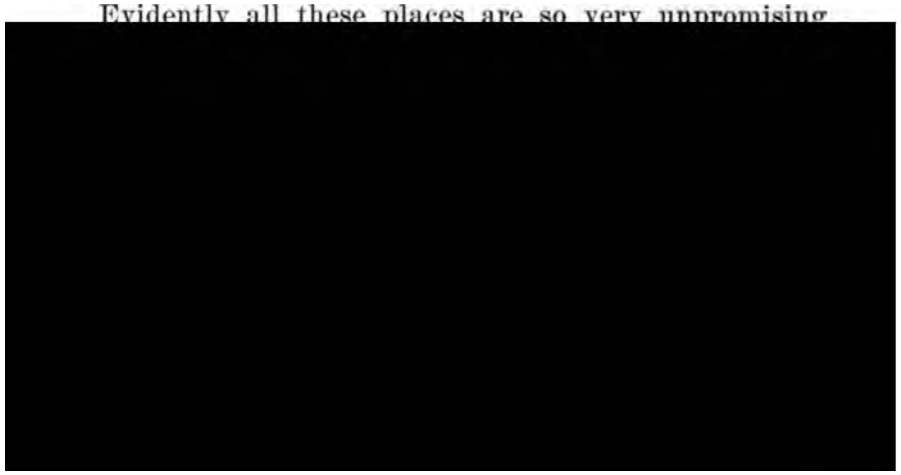
Several similar mines, on about the same geological horizon, four or five miles further west, in Chester

County, nearly a mile south of Phoenixville, were likewise abandoned some years ago, after a trial of many years.

Several beds among the Perkasie Shales contain traces of copper in the form of minute scales of bright green malachite. And on Abraham Charles's farm, half a mile south of Sumneytown, some trial shafts were sunk, mainly in 1889, but beginning about 1885, to test some still stronger evidences of copper ore. Apparently, however, only very insufficient traces of copper pyrites and malachite were found in a nearly vertical vein about seven inches wide, especially in the southern three inches. The vein is in dark reddish gray calcareous very hard shale, about 800 feet geologically below the top of the Perkasie Shales.

At about the same geological horizon and about a mile southeast of Sumneytown, on Abraham Kober's farm, three trial shafts were likewise sunk about 1879 to test some signs of copper ore; but without good success. The deeper holes, 50, 40 and 24 feet deep, were full of water and inaccessible when visited in 1889; but among the material that had been thrown out, there was a little malachite, copper pyrites and azurite, and some calcite. The vein was said to be two feet wide and to run east and west. A hole nine feet deep dug in 1889, showed traces of malachite.

Evidently all these places are so very unpromising



from the subjacent Paleozoic or Archean rock to be likely to have derived their ore from them instead of from the neighboring shales. The mines just mentioned and the New Galena Mine are so nearly on the same horizon as to make it seem not improbable that these veins also derived their ore from the adjacent shales.

GOLD.

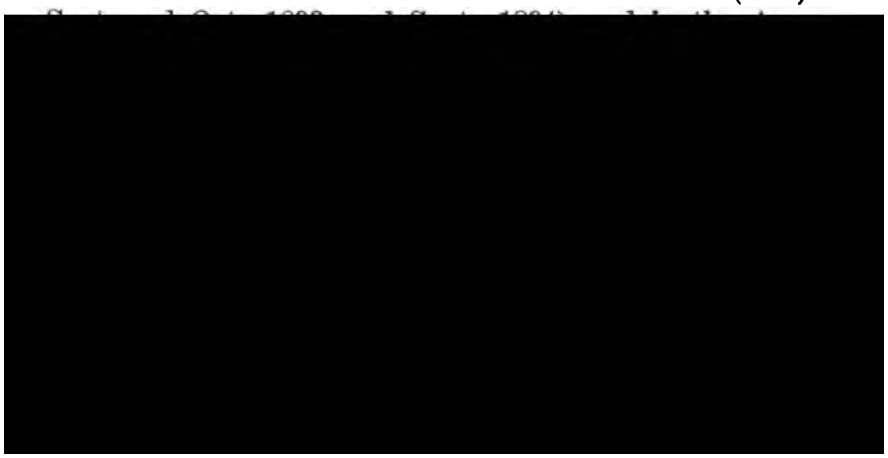
Traces of gold are said to have been found in the very pebbly rock at the southern edge of the field on Mr. Henry Haviland's farm, near Lizette Station, and a mile south of Yardleyville; but no thoroughly trustworthy tests of the matter appear to have been made. At the same time, it may be said that the occurrence of traces of gold in this conglomerate derived from the adjacent Archean rocks is by no means impossible. It is, however, hardly probable that paying quantities of it, if existing, should not long ago have been discovered and utilized.

UMBER.

A deposit of umber or dark ferruginous earth occurs on the south side of Buckingham Mountain, near the road-forks, where the road crosses the gap in the middle of the mountain, between Pineville and Centreville. A hole about three feet in diameter and said to be about 30 feet deep was dug there, but had quite fallen in when visited in 1889. It was first dug about 1850, but was renewed about 1885. The umber is said to have been darker and purer towards the bottom. Traces of it are said to have been found in a line for about a quarter of a mile southward; but none northward. The place appears to be just inside the Paleozoic rocks, here the Chikis Sandrock, and the traces found southward are probably merely superficial ones carried in that direction by the surface waters. The extent of the deposit is not likely to be very great; but cannot be estimated without more digging.

WATER.

Numerous deep wells have been bored with success for water. There is one about 1,000 feet deep at Pennsburg, sunk in the Pottstown Shales; five or more about 250 and 300 feet deep, at Lansdale in the Lansdale Shales; and two (one dry) at North Wales, in the upper edge of the Gwynedd Shales; and several in the Norristown Shales at Bridgeport, at Norristown, at Jeffersonville, Norriton Township; at Mogee's and Hickorytown, Plymouth Township; at Washington Square, Belfry Station and Sandy Hill, Whitpain Township, and probably elsewhere in Montgomery County; one at Doylestown, said to be 750 feet deep, and several at Newtown and probably other points in Bucks County; and no doubt at many other places in the field. The three sets of red shales would seem to give better results for such wells than the Perkasie Shales or the Gwynedd Shales. What is needed, of course, is a mass of porous beds overlain by comparatively close-grained ones. If the neighboring portions of the outcrop of the porous beds are at a high level, the water will rise in the well to a corresponding height. But apparently none of the wells flow with water at the surface without pumping. Prof. O. S. C. Carter has given details in regard to some of the wells near Norristown in the Franklin Institute Journal (Jan.,



description by Mr. W. J. McGee in the Am. Jour. of Sci., Vol. XXXV, p. 133.

The same formation seems to be visible, again, at Sunny Hill school house, two miles to the northeast, on the Newtown and Langhorne road, near the mouth of Core Creek, in Middletown Township, where there is an exposure of dark reddish gray, light brownish gray and light gray and brown coarse friable almost crumbling, sandrock; in the upper five feet, somewhat shaly with scattered pebbles of glassy quartz up to egg size, and through the lower three feet, soft nearly incoherent sand. The bedding is irregular, with much cross-bedding; and the dip is either level or slightly northerly.

The same formation apparently is seen yet once more at a quarter of a mile further eastward on the north side of Core Creek, in Middletown Township, where there is a roadside exposure of a dozen feet in thickness of mostly light brown and light gray, but in some thin layers dark brown, almost incoherent coarse pebbly sandrock. The bedding is irregular, and the dip seems to be nearly level, perhaps slightly towards the north-northwest.

The whole amount of these beds would seem to be not more than perhaps sixty feet, and they probably occur only at a lower level than the Sunny Hill schoolhouse; that is, for about four miles east from near the mouth of Mill Creek and mostly less than a quarter of a mile in width. No fossils have been found at any of the exposures, and the beds are not of a character favorable to the preservation of fossils.

MAP.

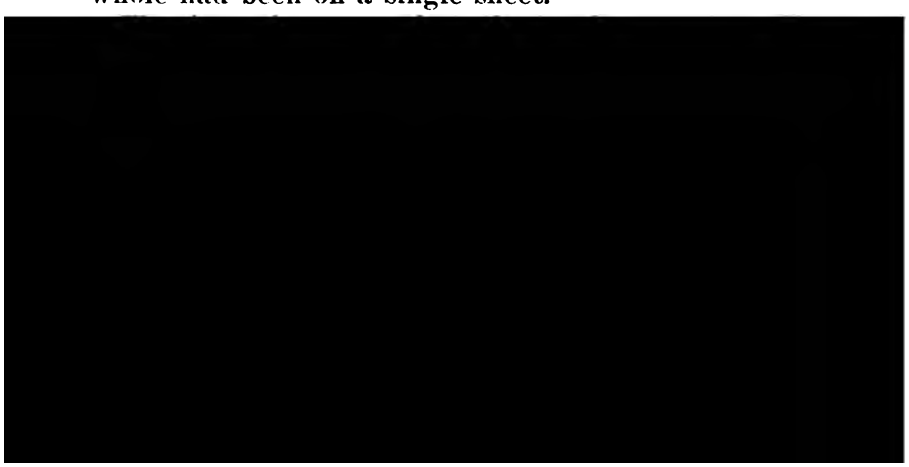
It seems on the whole best to explain certain defects in the printed map, for the benefit possibly of future publications, notwithstanding the risk of calling attention to shortcomings that might have passed unnoticed in some quarters.

As the map in two sheets is rarely united, the very

desirable effect of a connected view of the geology and topography of the whole field is generally lost. The map was drawn on the scale of an inch and a half to a mile with the expectation that it would be reduced by photography for printing to a scale of only one half or at most three quarters of an inch to a mile instead of the inch finally adopted; and evidently three-quarters of an inch would have been quite enough to display clearly all the essential facts, and the map could then have been on a single somewhat larger sheet, so as to show the whole field together. But for various reasons the larger scale was finally agreed to, with the expectation that the two sheets would be pasted together.

The manuscript map had upon it the houses scattered through the country, very useful indications, of course, as to the whereabouts of points in the field. But the increased expense made it desirable to consent to the omission of the houses, for the sake of good work in other respects.

The desire was to reduce the lettering on the map to a minimum, so as not to obscure the geology and topography. The names of places were accordingly abbreviated in a way that would be readily intelligible to anybody at all familiar with them, and to others it would be unimportant; but with a key to the names, that would have been sufficiently near at hand, if the whole had been on a single sheet.



all that was to be in black, including the topography and streams and the dips, with the topography re-enforced by shading the hills, would be inexpensive, and would be highly desirable, both for a better idea of the topography unobscured by the geological colors, and for use in any future additional observations in the field. But the increased expense the shading would have required caused it to be abandoned, and by a misunderstanding the lithographer omitted the dips; so that the usefulness of the edition was in a great measure lost. At the same time, the brown color of the contour lines diminished their effectiveness; and the several colors of course tended to make the expense disproportionate to the advantages.

The great distance of the lithographer and the difficulty of printing proofs with so many colors, occasioned some other less serious divergences from what was intended. It would be highly desirable if a satisfactory method of photolithographing manuscript maps could be devised, so that the reproduction of the original work should be exact in all details.

Several assistants co-operated faithfully and zealously in the field work and mapping: Messrs. Amos P. Brown and Jos. Sketchly Elverson, for several months, chiefly in 1889, aided in the field in carefully observing the rock exposures, bed by bed, for the lithological character and thickness of each layer, and in taking specimens and reading the aneroid; and, in the office, helped in the mapping and in labeling the specimens. The last three months of 1889, Messrs. C. H. Kajiwara and F. Koch aided in the field-work and office-work in the same ways and continued in the office the first half of 1890, tracing the mapping and drawing columnar sections. Mr. Kajiwara kept on at such office-work work until September, 1891. In the summer of 1890, Mr. A. DW. Smith assisted in the mapping

for a couple of months and in a few days of fieldwork; and later he drew the latitude and longitude lines of the map, and had oversight of the copying of the topography of the sheets of the United States Geological Survey. Mr. Chas. J. Wright aided in such copying, and in tracing it and several township maps; and Mr. Howell T. Fisher aided in the lettering. Much gratitude is due to the State Geologist for the kindly interest shown throughout the work and the complete freedom accorded.

The following twelve plates (Pl. 600-611) were prepared by the State Geologist to illustrate the fossils of the New Red.

BENJ. SMITH LYMAN.

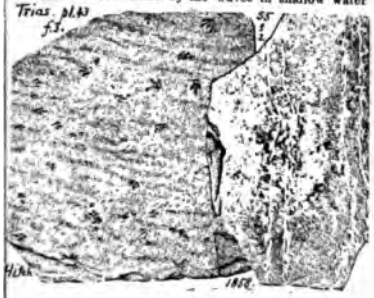
Philadelphia, 8th July, 1895.



PLATE 600

Triassic (Mesozoic) ripple marks, &c.

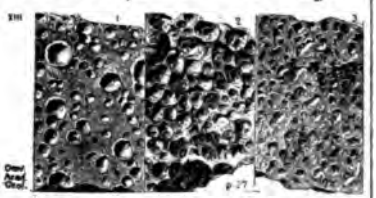
Ripple marks made by the waves in shallow water



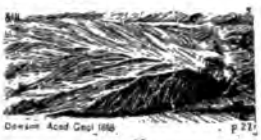
Rain drops on ripple marks.



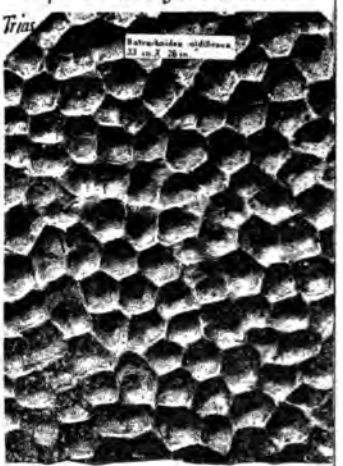
Rain drops in the Coal age.



Rill marks

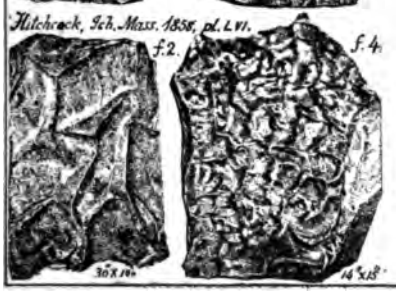


Tadpole nests fossilized.



Sun-cracks of various forms fossilized







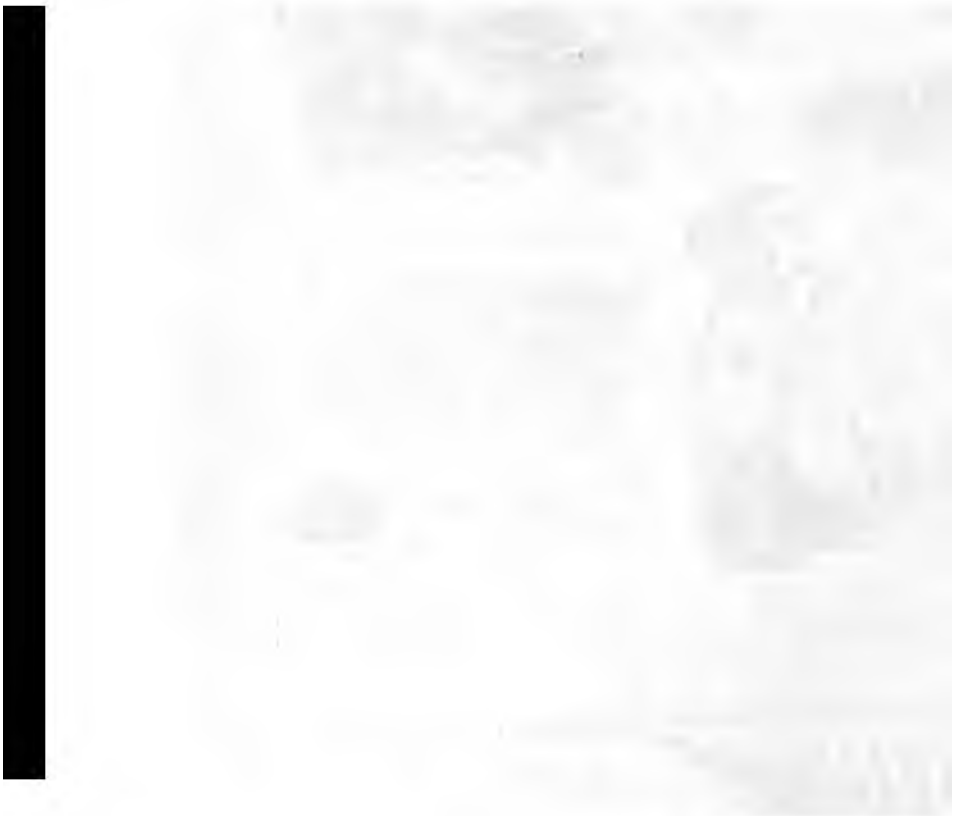
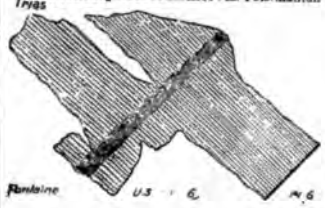


PLATE 602

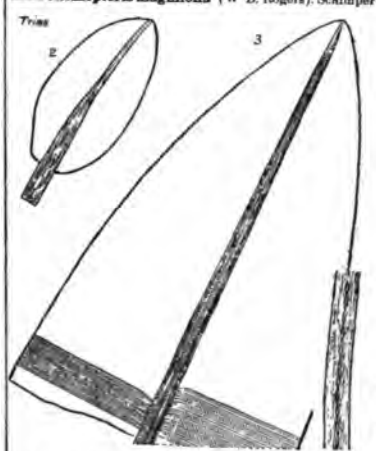
Triassic (Rhætic, Mesozoic, Newark) plants.

Macrotæniopteris crassinervis. Feistmantel.
Trias

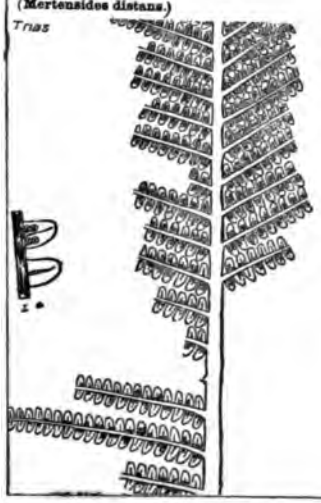


Fontaine U.S. Mon. 6. Pl. 6

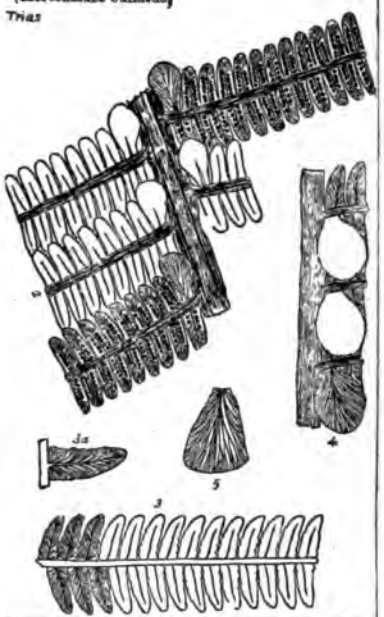
Macrotæniopteris magnifolia (W. B. Rogers). Schimper
Trias



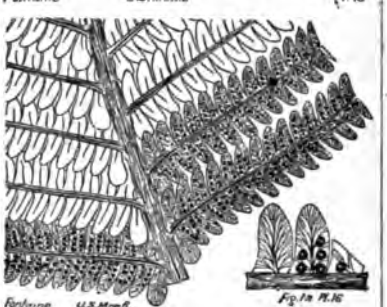
(Mertensides distans.)
Trias



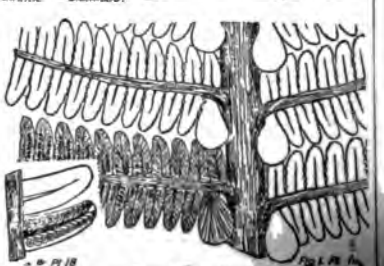
(Mertensides bullatus)
Trias



Fontaine U.S. Mon. 6. Pl. 15



Fontaine U.S. Mon. 6. Fig. 1a Pl. 16

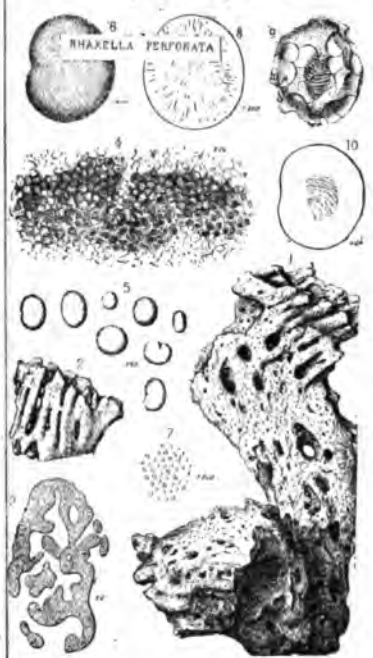


2a Pl. 18

PLATE 601

Triassic sponges and (Rhætic) plants

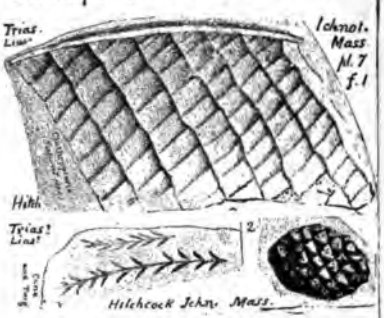
Sponges of Jurassic or Middle Oolite age in England.



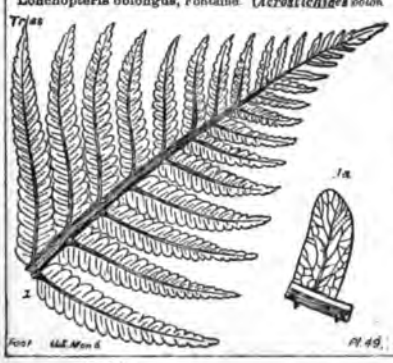
Radiatæ in Connecticut river sandstone. Hitchcock



Clathopteris retusculus.



Lonchopteris oblongus, Fontaine. *Ucrostichides oblon.*



Lonchopteris virginiensis. Font.

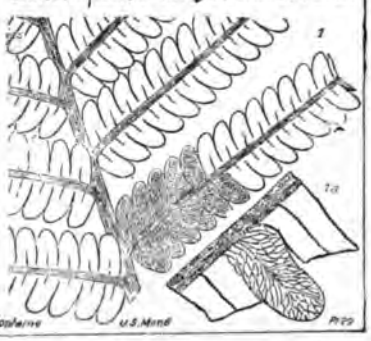
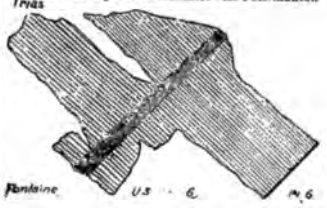


PLATE 602

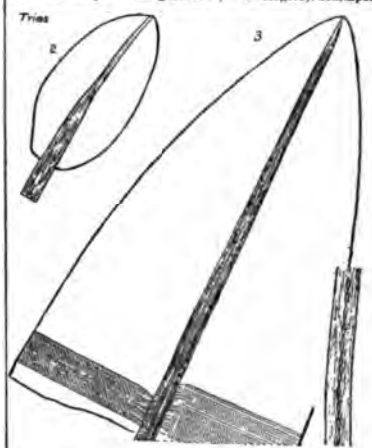
Triassic (Rhætic, Mesozoic, Yewark) plants.

Macrotæniopteris crassinervis. Feistmantel.
Trias

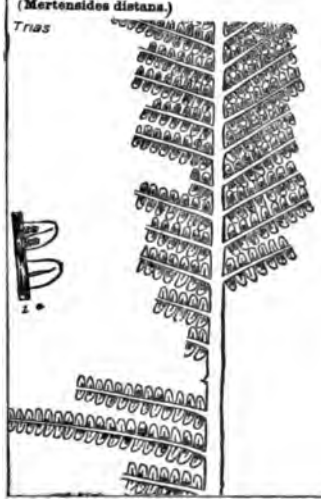


Fontaine U.S. &c. Pl. 6.

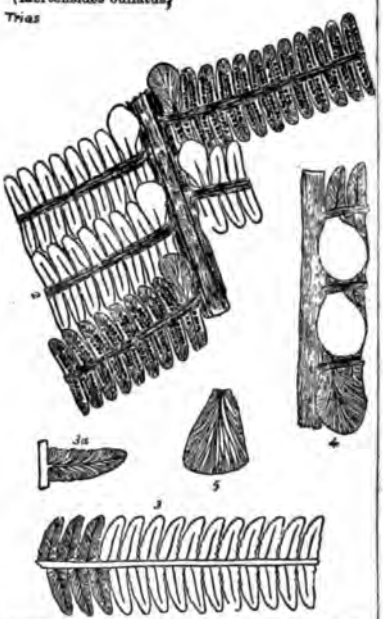
Macrotæniopteris magnifolia (W B. Rogers). Schimper
Trias



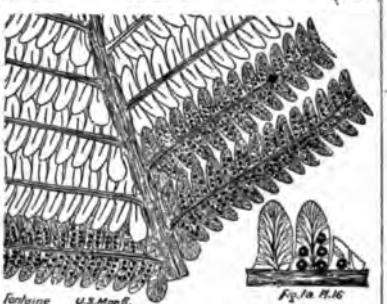
(Mertensides distans.)
Trias



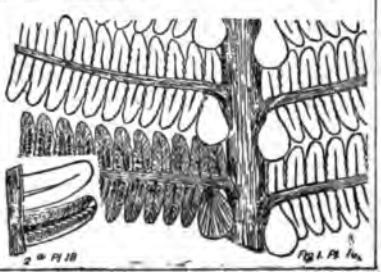
(Mertensides bullatus)
Trias



Fontaine U.S. Mon. 6 Pl. 15



Fontaine U.S. Mon. 6. Fig. 1a Pl. 16



2 de Pl. 18 Fig. 1 Pl. 16

PLATE 603

Mesozoic (Triassic, Rhætic) plants.

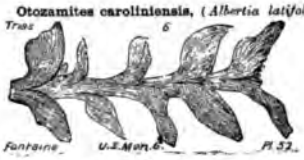
Otozamites latior.



Otozamites brevifolius, Fr. Brogniart, Newberry



Otozamites caroliniensis, (*Albertia latifolia*,



Pachyphyllum peregrinum,



Pachyphyllum simile, Newberry



Pachyphyllum brevifolium, Newberry



(Palissya braunii.
Trias



Palissya ? Trunk of a conifer, decorticated.



PLATE 604

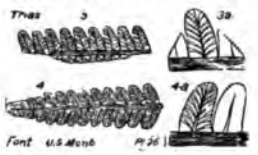
Mesozoic (Triassic, Rhœtic) plants.

Palissya carolinensis. (*Pachypteris* Emmons



Font. Grot Sur. U.S. Mon. 6. Pl. 51. fig 5.

Pecopteris rarinervis, Fontaine

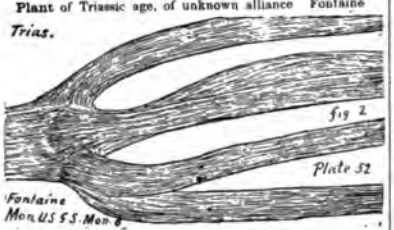


Font U.S. Mono Pl. 36

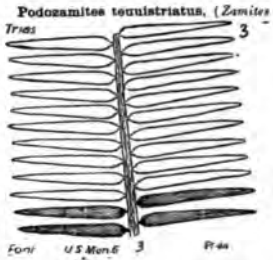
Palissya diffusa



Plant of Triassic age, of unknown alliance Fontaine



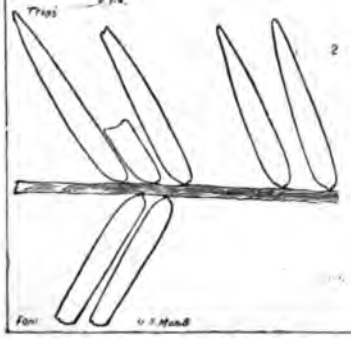
Podozamites tenuistriatus, (*Zamites*



Font U.S. Mon. 6 3 Pl 44

Podozamites emmonsi. Fontaine (*P lanceolatus*, Em





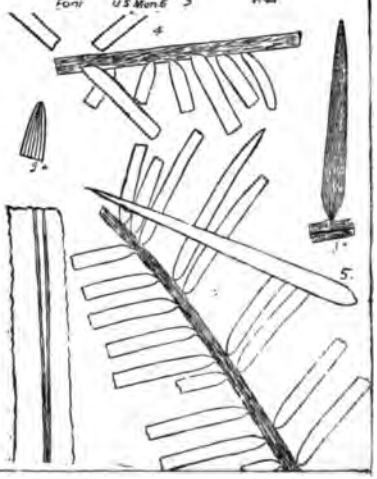


PLATE 603.

Mesozoic (Triassic, Rhætic) plants.

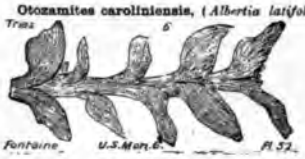
Otozamites latior.



Otozamites brevifolius, Fr. Brogniart, Newberry



Otozamites caroliniensis, (*Albertia latifolia*,



Pachyphyllum peregrinum,



Pachyphyllum simile, Newberry



Pachyphyllum brevifolium, Newberry



(Palissya braunii.
Trias



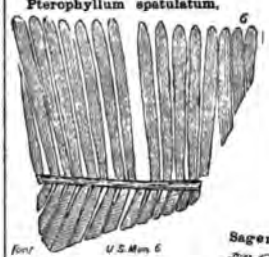
Palissya ? Trunk of a conifer, decorticated.



PLATE 606

Mesozoic (Rhœtic, Connecticut) sandstone.

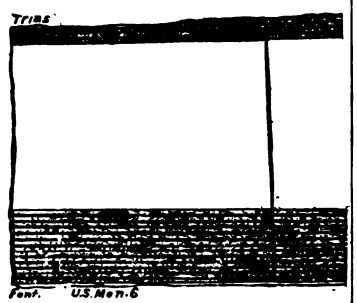
Pterophyllum spatulatum,



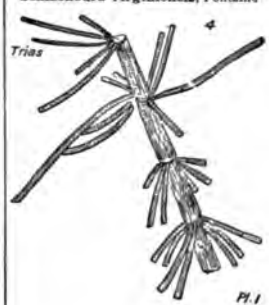
Sagenopteris rhoifolia ?



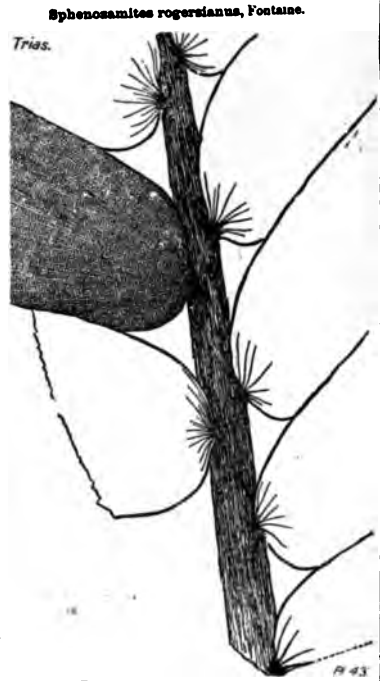
Schizoneura plagiostata. 943



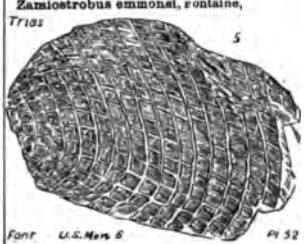
Schizoneura Virginiensis, Fontaine



Sphenozamites rogersianus, Fontaine.



Zamiostrobus emmonsi, Fontaine,



Zamiostrobus virginiensis, Font..



Zamiostrobus —— ? Emmons.



PLATE 607

Mesozoic (Rhætic, Trias, Connecticut) SS.

Neorthroblattina rotundata cockroach wing;



Trias

Fig. 908.

Poroblattina lakesii, Scudder.



Trias

Zittel. 936

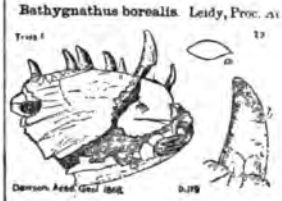
Spiloblattina gardneri, Scudder



Trias

Zittel 938

Bathygnathus borealis Leidy, Proc. A



Trias

Dawson. Acad. Geol. 1868. p. 379

(**Pterodactylus longirostris**

Jura



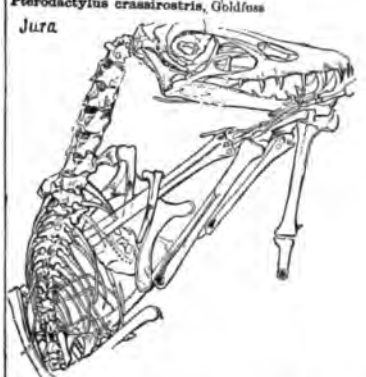
Pterodactylus brevirostris, Cuvier

Jura



Pterodactylus crassirostris, Goldfuss

Jura

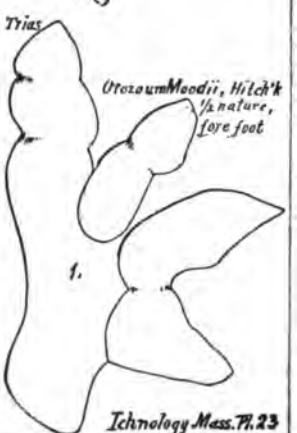


Trias

Otozoum Moodii, Hitch'k

½ nature,

fore foot



1.

Tracks of *Grammichnus alpha*, Hitchcock. Supplement

Tri.



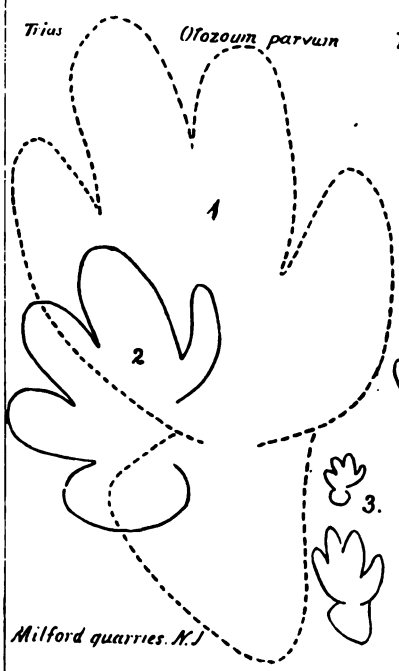
Fig. 3 *Grammichnus alpha*

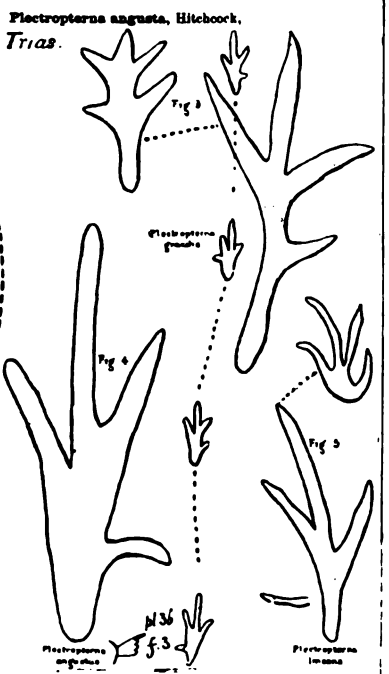
Pl. III.

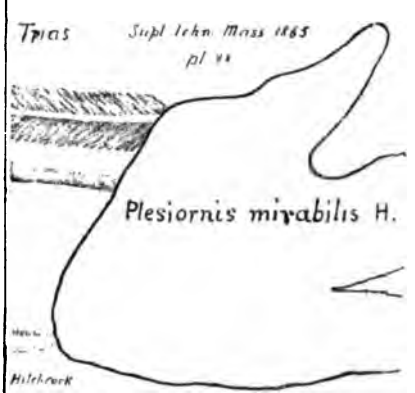
Ichnology Mass. Pl. 23

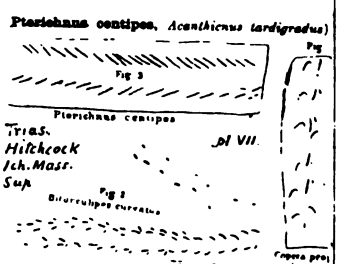
PLATE 608

Mesozoic (Connecticut) sandstone tracks









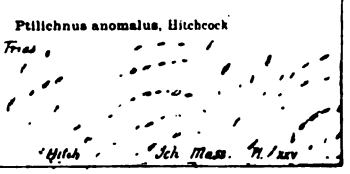
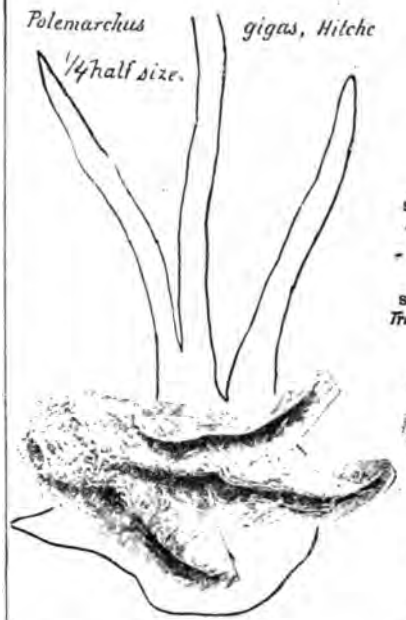
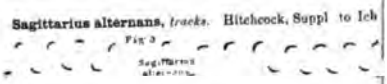


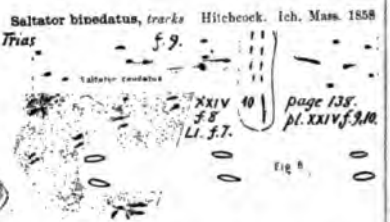
PLATE 60 B

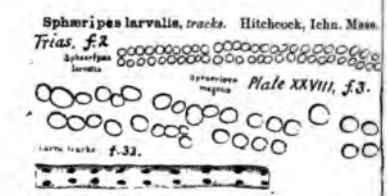
Triassic reptile tracks &c. Massachusetts.

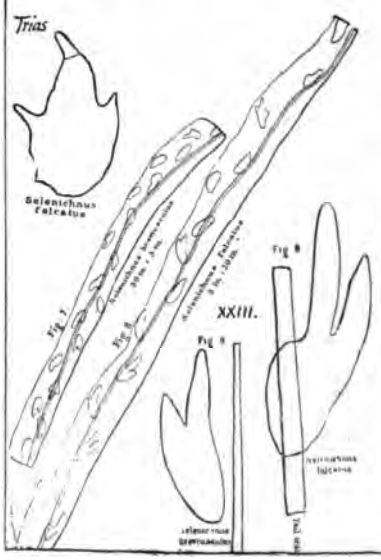














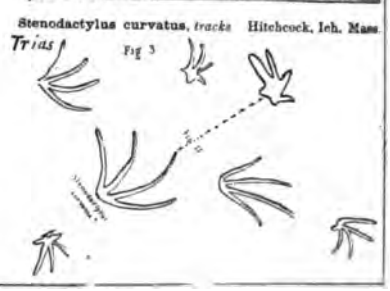
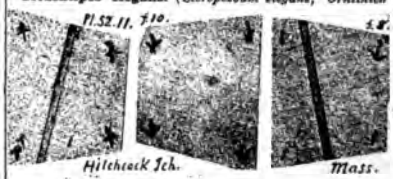


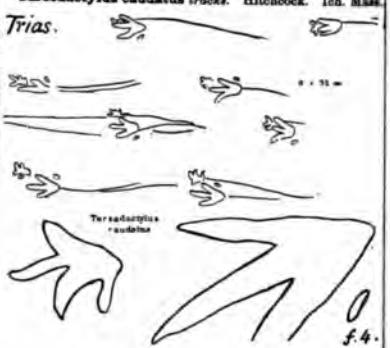
PLATE 610

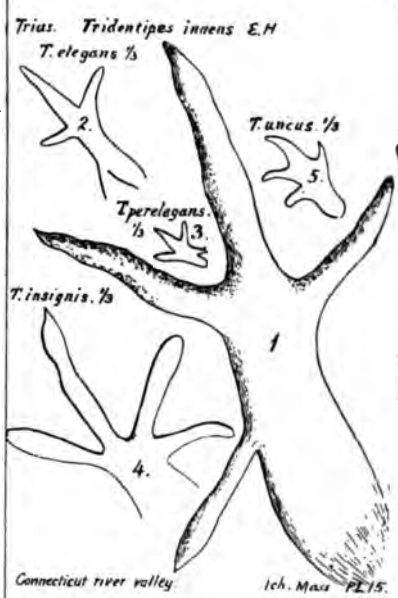
Triassic reptile tracks. Amherst Museum.

Tridentipes elegans. (*Stereopezoum elegans; Ornithich*

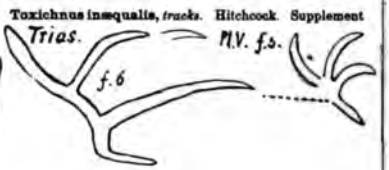


Tarsodactylus caudatus *tracks.* Hitchcock. Ich. Mass.

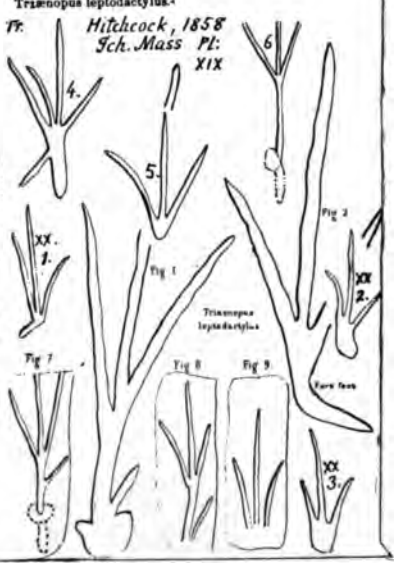




Toxichnus inequalis, *tracks.* Hitchcock. Supplement



Trisenopus leptodactylus.



Tridentipes perelegans (*elegantior.*) Edw. Hitchcock, Ich



PLATE 61

Triassic reptile and worm tracks, and fishes.

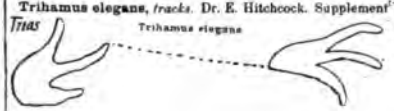
Tridentipes uncus, Ed. Hitchcock, Ichnology



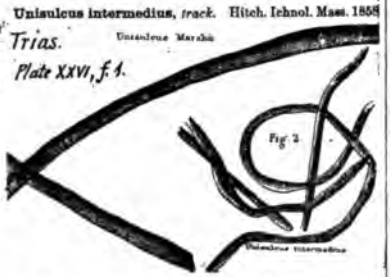
Trisulcus laqueatus, *worm track.* E. Hitchcock.



Trihamus elegans, *tracks.* Dr. E. Hitchcock. Supplement



Unisulcus intermedius, *track.* Hitch. Ichnol. Mass. 1858



Triænopus leptodactylus.



Xiphopeza triplex, track. Hitchcock. Ich



Typopus gracilis.



Ptycholepis marshii, Newberry.

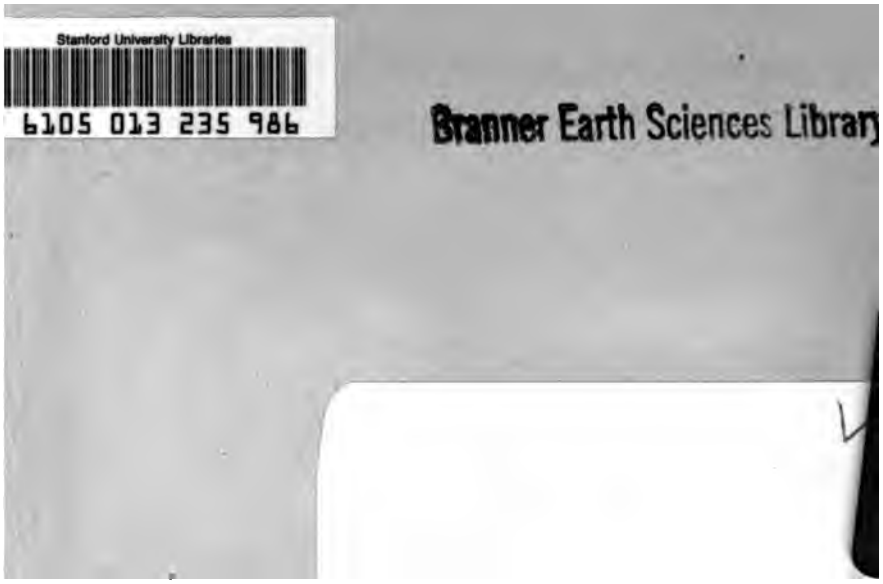


Unisulcus minutus, *worm track.* Hitchcock Ich



Clepeysaurus pennsylvanicus.





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